THURSDAY, AUGUST 2, 1900.

WEAPONS AND WOUNDS.

Les armes blanches; leur action et leurs effets vulnérants. By H. Nimier, Professeur au Val-de-Grâce, and Ed. Laval, médecin aide-major de première classe. Pp. 448. (Paris: Félix Alcan, 1900.)

Les projectiles des armes de guerre; leur action vulnérante. By the same authors. Pp. 212. (Paris: Félix Alcan, 1899.)

Les explosifs, les poudres, les projectiles d'exercice; leur action et leurs effets vulnérants. By the same authors. Pp. 192. (Paris: Félix Alcan, 1899.)

THESE volumes, although their titles are formidable enough, can scarcely be said to exhaust the subject of the means invented by man for the special purpose of destroying his own race. Prof. Nimier, one of the authors, is well known as a writer on military medical subjects, and no doubt he has thought it unnecessary to repeat much of what he has already written on these and cognate subjects. The volumes, however, fill considerable gaps in our own literature. We have few writers in this country whose works stand out prominently as works of importance on the same subjects during the present century. Guthrie and Ballingall are practically the only writers whose contributions to the subject cover the period between the Peninsular and the Crimean Wars. Since then, Longmore's classical work on gunshot injuries was the sole work of reference until a year or two ago, when Stevenson, his successor in the Army Medical School at Netley, brought our knowledge of the injuries likely to be produced by modern fire-arms up to date. On the Continent the system of compulsory military service is responsible for the fact that these subjects excite widespread interest amongst the general and scientific public to a much greater extent than in England; and many important additions have been made to the literature of wounds in war by continental writers within the last few years.

The bulkiest of these three volumes treats of a class of weapons which nowadays play a comparatively unimportant part in wars between civilised Powers—namely, the bayonet, sabre, sword, lance and arrow. This volume also contains a chapter on defensive armour. We were much disappointed in finding that its bulkiness, instead of being due to pages full of historical detail, as we had anticipated, depends largely upon needless repetitions of the diagnosis, prognosis and treatment of the wounds produced in the different regions and tissues of the human body by the various weapons included in the term *armes blanches*. These repetitions are wearisome and unnecessary. The wounds produced by side-arms differ in no way from the contused, incised, punctured or poisoned wounds described in text-books on general surgery. In other words, there is no *specialism* in the subject for the student of physical, military or medical science, except perhaps that portion of it which deals with arrows and arrow poisons.

The volume, however, is of much value as a work of reference for any one desirous of comparing the shape and construction of the side-arms used by the several European Powers. The chapters on the bayonet and mixed types of bayonet are specially interesting in this respect. The introduction of the magazine rifle has led to important changes in the length and weight of the bayonet and to its probable use in future wars. The short knife-bayonet is now almost universally adopted; the shortest being the 21 centimètre long Norwegian bayonet, used with the Krag-Jörgensön rifle; as compared with the British Lee-Metford bayonet of 30 centimètres. The Austrian, German, Italian and Spanish bayonets hold an intermediate position between these two. Russia and France, on the other hand, still retain the long, narrow-pointed bayonet. Thus the Russian bayonet, 1891 pattern, measures 43 centimètres, and the French Lebel bayonet 52 centimètres with a weight of 466 grammes. Some idea of the slender stiletto-like proportions of the latter may be formed from the fact that, although nearly twice as long, it weighs actually less than the Lee-Metford bayonet. The authors enter somewhat fully into reasons why the Russians and French prefer this long weapon of offence to the shorter bayonet, which they describe as being intended more for lopping branches of trees and digging trenches than for any other purpose in war. They agree in thinking that, in modern pitched battles, the last phase, namely, the charge, *restera à l'état purement platonique*, one side yielding to the other without waiting for cold steel. But surprises, night attacks and assaults on convoys are circumstances of war which will occur as frequently in the future as in the past; and it is these that render the retention of the bayonet as a weapon of offence of paramount importance. The Russians recognise this fact so well that their cavalry carry a bayonet for use with the carbine. The authors also refer to the national temperament of the French as one of the reasons why they have not followed the example of neighbouring European countries in adopting a bayonet more suitable for camp purposes than as a weapon of offence. The French, they say, are specially fond of side-arms as weapons, by which we assume that the national temperament urges them to get to close quarters as soon as possible. This, however, seems scarcely sufficient reason for the preference they have for a long narrow bayonet. Our own soldiers, at any rate, have amply proved in the present campaign in South Africa that the short, stout bayonet possesses destructive and moral effects possibly equalled, but certainly not excelled, by the longer weapon. The authors have little to say that is of interest with regard to the sabre, sword and lance. The type of these weapons is practically the same in all civilised countries, and the chapters on them are mainly descriptive.

Arrows and arrow poisons are fully discussed, the chapter on them being mainly a *résumé* of the investigations made by the French naval surgeons, Le Dantec, whose tables of the geographical distribution and classification of arrow poisons are given in detail. The subject is occupying much attention at present in this country in consequence of the rapid extension of European spheres of influence in the African Hinterland, where poisoned arrows are so widely used by aboriginal tribes. Those who are interested in the subject will find accurate and important details in this chapter, but it

must be confessed that English readers have fuller historical and scientific information available on arrow poisons in the inaugural address delivered by Prof. Stockmann, of Aberdeen University, to the North British Branch of the Pharmaceutical Society in 1898 (*Pharmaceutical Journal*, November 26 and December 3, 1898). It is interesting to note how thoroughly Prof. Stockmann's ethnological distribution of arrow poisons—a distribution which is extremely well marked—agrees with that of the French writers. In their description of the methods adopted for the propulsion of arrows and similar projectiles, the authors make no mention of the use of the blowpipe, a somewhat formidable weapon in the hands of Bornean aborigines.

In the chapter on defensive armour there is a guarded reference to what may prove of considerable importance in the future. In the helmet and cuirass we still possess the relics of a period when nations fought with sword and lance; but the opinion is gradually gaining ground that the use of defensive armour in the form of shields for protection against the projectiles of modern fire-arms may become a feature in future wars. The Danish Army have already adopted a form of shield for this purpose, and the principle is also recognised in the use of shields with the quick-firing automatic guns of the Maxim type.

The authors' contribution to the subject of projectiles deals with modern fire-arms only; and, with the exception that the projectiles of the automatic guns are not considered at all, the information on the subject is concise and complete. Modern small-arm projectiles are exceptionally well described. The physical qualities of these projectiles are remarkably similar in the different European countries, the chief variation in form being in the calibre of the bullet, which is between 6·5 and 7 millimètres sectional diameter for Italy, Holland, Norway, Roumania and Spain, and between 7 and 8 millimètres for other countries, the smaller calibre of the former being compensated for by greater length. The dynamic properties, however, have considerable and important variations, which the authors describe with the lucidity and precision characteristic of French writings on subjects of this nature. The chief practical interest in the dynamics of projectiles lies in the relationship between these properties and the surgical results. The principle to which the modern small-arm projectile owes its origin is indicated in the formula $f = mv^2$. In other words, the production of a bullet with a high rate of velocity at the expense of mass has been the object attained in the adoption of magazine rifles. But it is gradually dawning upon the military mind that the equation of work, expressed by the formula $o = \frac{mv^2}{2}$, does not express accurately the relative values of velocity and mass in the surgical results. The first occasion on which our own troops used the high velocity small calibre bullet in actual war—namely, in Waziristan in 1895—proved the fallacy of the formula in this respect; and it is now fairly well recognised that the mass of the projectile is probably as important a factor in producing surgical disaster as its velocity. No doubt the actual power of penetration and the resistance required to bring the projectile to a state of rest is accurately expressed by the formula; but it is this very power of penetration, depending so much on increase of velocity combined with reduction of mass, that has earned for the modern bullet the epithet humane. To pursue the subject further would lead to a variety of speculations as to the nature of the weapon of the future. The authors clearly recognise this, and are inclined to regard the action of the United States of America in reducing the diameter of the projectile of the naval small arm to 6 mm. as indicating a tendency to convert modern firearms into *carabines de salon* or *fusils d'enfants*. They are apparently much in sympathy with the use of bullets that deform or expand on impact, or at any rate produce shock, and fear that the agitation against these bullets will only lead to the use of some more deadly projectile in the future. These expanding or deforming bullets and their effects are fully described. The best known example is the soft-nosed Lee-Metford bullet, but the authors refer also to the use of the Lebel bullet with the hard envelope stripped at the apex. They state, however, that the latter does not expand on impact, although it produces shock. Another interesting example of the expanding bullet is the Swiss bullet, which has the lead core naked at the base instead of at the apex. The deformity in this bullet after impact, by the incurving of the soft base, is said to be as great as, if not greater than, the deformity at the apex of the Dum-dum type of bullet. The explosive effects sometimes caused by high velocity bullets are also very clearly discussed, but no new light is thrown upon this very curious phenomenon. The authors adhere to the generally accepted theory that the effects are due to secondary energy transmitted to tissues of a certain nature or in a certain state of tension. The possible part played by ricochets, deformities, and varying angles of impact is not mentioned in this connection. There is also entire absence of any reference to the use of true explosive bullets, which, although abolished by international agreement in 1868, are alleged to have been employed by some Boer commandos in the war that is now being waged in South Africa. The chapter on artillery fire is interesting and valuable, and concludes with a suggestive article on the moral effects of this branch of the service. In other respects the dynamics and ballistics of artillery projectiles and the wounding effects of fragments of shells, projectiles, &c., are worked out on the same lines as in the chapters on small-arm projectiles.

In the volume on explosives there is a variety of details, not readily obtained elsewhere in the same compact form, and on this account it is perhaps the most valuable of the three volumes to the student of military surgery or medical jurisprudence, to whom it is chiefly of interest. The effects of the various explosives in use are amply illustrated by historical incidents, especially incidents connected with anarchist attempts and with explosions in stores, ships and arsenals. The explosives used in the cartridges of the small-arms of different countries are also well described and compared. The authors include in this volume a chapter on the accidents connected with sapping and mining, a subject which we do not remember to have seen noticed in other works of a similar nature. The physical phenomena of a peculiar form of *intoxication* or suffocation to which sappers are

liable are fully described and not generally known in this country.

The complete absence of bibliographic references is a notable defect in the volumes, more especially as they are mainly compilations of the works of other writers and investigators, whose names appear frequently in the authors' pages. In fact the reader, who might wish to consult the original works, will have great difficulty in knowing where to look for them. We are always glad, however, to welcome any contribution to a literature which is so meagrely represented in our own country.

W. G. M.

PLANTS OF THE PAST.

Éléments de Paléobotanique. By R. Zeiller. Pp. 421. (Paris: Carré and Naud, 1900.)

SOME of the most striking advances in botanical science during the last two or three decades have been in the domain of Palæobotany. The study of fossil plants is now generally recognised as a science of primary importance, which affords, not merely useful data for the stratigraphical geologist, but furnishes valuable information as to the course of plant evolution, and enables us to connect some of the phyla of the plant-kingdom at points where their common origin is clearly indicated. Prof. Zeiller, of the École des Mines, Paris, has played a prominent part in placing fossil botany on a thoroughly scientific basis; his work, which embraces a wide field, is characterised by a philosophical handling of facts, a thoroughness of treatment and a breadth of view that are too frequently lacking in scientific writings of the present day. In the book before us Prof. Zeiller has performed a difficult task with considerable success. Within a small compass he has included a systematic though necessarily brief account of the more important types of fossil plants, and concise and clearly-written chapters on various subjects of geological and botanical interest. The illustrations are well executed, and it is a pleasure to note that many of them are new. In the section treating of the preservation of plants as fossils, Zeiller draws attention to a method of examination of "impressions" which he has used with considerable success. It is often possible, after suitable chemical treatment, to examine microscopically the thin carbonaceous film, which may sometimes be detached from the surface of a plant fragment lying on a slab of shale, and in this way to obtain important information as to anatomical details.

Some interesting examples of the Siphoneæ are figured and briefly described; but one or two of the examples quoted, *e.g.* the supposed *Caulerpa* from the Kimmeridge Clay, are of very doubtful value. The fossil Myxomycetes of Palæozoic age, described by Renault and other authors, should be mentioned with a word of caution as to their acceptance as undoubted Mycetozoa. In describing the vascular cryptogams, Zeiller notes the danger of attaching too much importance to the presence or absence of secondary wood, or to the isosporous or heterosporous character of a genus; mistakes made in the past, which have persisted for many years, emphasise the need of this caution.

In discussing the systematic position of various extinct generic types of exceptional interest which point to a common origin of cycads and ferns, Zeiller speaks of the collateral form of the vascular bundles as one of those cycadean characters which is met with also in recent ferns. It is, however, important to bear in mind the fact that in the collateral bundles of *Ophioglossum* and other ferns the protoxylem occupies an endarch position, while the cycadean type of bundle is usually mesarch.

The chapter on fossil ferns is particularly well done, and contains much that is new. The genus *Microdictyon*, mentioned by Zeiller as a mesozoic fern closely allied to *Laccopteris*, is hardly sufficiently distinct to be retained as a separate type.

The enlarged photograph of a leaflet of the well-known "fern," *Alethopteris Serlii*, given to illustrate the occurrence of what may possibly be traces of sporangia, does not afford satisfactory evidence that this fern-like frond bore fern-like sporangia. We are still in want of convincing evidence as to the nature of the reproductive organs of both *Alethopteris* and *Neuropteris*, genera in which the characters of ferns and cycads were combined.

A drawing is given of an exceptionally fine example of a rhætic fern—*Clathropteris platyphylla*—from Tonkin; as Zeiller has shown, this plant may be compared with the recent genus *Dipteris*, which, like *Matonia pectinata*, represents a tropical survival of a widely-spread mesozoic family of ferns. The inclusion of the genus *Sagenopteris* with the Hydropterideæ, rather than with the Filices, is perhaps a little rash, as the evidence so far available as to the reproductive organs is by no means conclusive.

A good description is given of the genus *Sphenophyllum*, but it is to be regretted that exigencies of space prevent full justice being done in this and other cases to the account of anatomical features. Zeiller discusses the possibility of *Sphenophyllum* having lived as a water-plant in the Coal period forests, but it is perhaps more probable that its long and slender stems were supported, like lianas, by the boughs of stouter trees.

In dealing with the Calamarieæ, Zeiller does full justice to the work of English authors, and discusses controversial points with admirable judgment and an open mind. The genus *Sigillaria* is described as a true lycopodiaceous plant, agreeing in certain respects with *Isoëtes*.

In the account of fossil cycads, Zeiller, like other authors, quotes an example of a cretaceous *Cycas* carpophyll, figured by Heer, from Greenland; the figured specimen, which the writer has seen in the Copenhagen Museum, is not sufficiently well preserved to be determined with certainty, and bears but a distant resemblance to Heer's figure. The genus *Podozamites*, placed by Zeiller among the Cycads, may possibly be more correctly included in the Coniferæ, but it is a type of somewhat doubtful position. The flowers of *Zamites gigas*, usually known as *Williamsonia*, mentioned in the section dealing with the Bennettiteæ, are usually of Inferior Oolite rather than Lower Lias age.

Prof. Zeiller gives a useful summary illustrating our knowledge of fossil angiosperms; as he points out, the literature on Tertiary plants is in urgent need of revision

at the hands of experienced systematists. The concluding chapter, dealing with the bearing of palæobotanical evidence on plant evolution, is full of interest, and particularly valuable as being written by one who possesses both a wide knowledge of the available data and the power of critically weighing the evidence. Referring to the comparative study of species of fossil plants, Zeiller writes:

"Les Espèces, commes les genres, se succèdent par voie de substitution et non par voie de transformation graduelle, et il en parait être de même à tous les niveaux."

A very useful bibliography of writings referred to in the text is given at the end of the volume. A. C. S.

PHOTOGRAPHY IN NATURAL COLOURS.

Lehrbuch der Photochromie (*Photographie der natürlichen Farben*). Von Wilhelm Zenker; neu herausgegeben von Prof. Dr. B. Schwalbe. Pp. xiii + 157. (Braunschweig: Vieweg und Sohn, 1900.)

IN 1868, after long study and repetitions of Edmond Becquerel's experiments on photochromy, Dr. Wilhelm Zenker himself printed and published a "Lehrbuch der Photochromie," which contained a physical explanation of the colour-correctness of these photochromatic images. Zenker's book did not have a wide circulation—it would be difficult, perhaps, to name any one in England who has read it—and it was not until 1890 that Lippmann, by founding a *new* method on the principle suggested by Zenker, drew a slightly increased attention to Zenker's labours. That the attention was only slightly increased was due to two causes: firstly, the rather astonishing *results* of Lippmann and others helped to overshadow the *principle* of Zenker in the eyes of most people; secondly, among all those whose pursuits have any claim to be considered as scientific, English photographers are especially noticeable for their deliberate ignorance of the creative work of the past in photography.

For the latter reason, chiefly, the present writer has given, during the past year, a rather full analysis of Zenker's work in "Camera Obscura," and we have now a reprint, in good *English* type, of the book. In the words of the preface, "The more modern researches on photography in natural-colours have shown that the way and the explanations of modern attempts are connected in many respects with Zenker's ideas." The volume contains besides a portrait of Zenker, a sketch of his life and index of his works by Prof. Gustav Krech; and, finally, Herr E. Tonn gives (pp. 131-157) an account of the further development of photochromy on the foundations of Zenker's theory. We shall notice these briefly in their order; but, with regard to the "Lehrbuch" itself, shall abstain from entering at all fully into the subject of its contents, as in the above-cited reference there is already a full account of it in English.

Wilhelm Zenker (1829-1899) cultivated many different branches of knowledge. His first papers (1850-1866) were zoological; the "Lehrbuch" was his first contribution to photography; and his other papers were on colour-perception (1867), photography and physical optics, astrophysics, and, in later life, meteorology. The "Lehrbuch," however, is probably the most important of his works, and it is to be hoped that now, with this excellent reprint, his methods will have some influence on English photography.[1]

The book is divided into three parts: (1) Considerations on colours ("Das Wesen der Farben"); (2) Account of his predecessors' work in photochromy ("Die Wiedergabe der Farben"); and the third part ("Theorie der Photochromie"), after an account of the theories of Seebeck, Becquerel and others, contains Zenker's own ideas (pp. 116-129). There are one or two useful notes to this section.

Herr Tonn's section, with one exception, seems very complete, and full references are given. It is, however, a pity that the very pregnant hint of Lord Rayleigh should be unnoticed (*Phil. Mag.*, 1887). Lord Rayleigh, independently of Zenker, and starting from totally different considerations, indicated in a footnote the Zenker principle, and even went farther; for not only did he seek to *explain* the results of Becquerel by this principle, but seemed to see the possibility of a *new* method of photochromy based on it. It would be interesting to have some account of Lord Rayleigh's then promised experimental investigations. If Herr Tonn knew this paper, it is difficult to understand how he resisted the temptation of comparing Rayleigh and Zenker—Zenker who was so clearly a non-mathematician.

The chief value of the book, the writer persists in believing, is not historical—for it *has* not had very much influence in the moulding of thought—but is in its spirit; the influence of its point of view and methods is needed above all at the present time for English photographers; this does not mean, of course, the small number of English *photo-chemists*.

PHILIP E. B. JOURDAIN.

OUR BOOK SHELF.

Die Harze und die Harzbehälter. By A. Tschirch. Pp. viii + 417. (Leipzig: Gebrüder Borntraeger, 1900.)

THE author has spent eight years in collecting and arranging the scattered facts relating to the obscure group of organic compounds which are classified as resins by virtue of a common physical characteristic.

What Kekulé termed "the chemical lumber room" contained at one time a collection of similar obscure groups, such as the alcaloids, colouring matters, tannins, aromatic compounds, &c.; but since the year when that chemist gave to the world his benzene formula, the lumber room has been industriously ransacked and its contents dragged forth into the light of day. Perhaps the resins have received the scantiest share of attention; partly, no doubt, owing to the practical difficulties which they offer to the chemist.

We know nothing of the molecular state which finds its physical expression in these amorphous, translucent compounds, nor how to bring them into a condition of ascertained purity. How often does a promising research miscarry by the unwelcome appearance of resinous products! Nevertheless the mass of research which has accumulated on the subject fills 400 closely printed pages.

A great amount of this research gives very little indication of the nature of the resins themselves. The older chemists distilled them and obtained products such

[1] His work for the Paris Academy prize in 1868 stands in close relation to his theory of photochromy (see Fizeau's report, *Compt. rend.*, lxvi., lxvii.). Zenker's memoir was never published, and Otto Wiener (*Wied. Ann.*, 1890, 1895) later and independently followed the same train of thought. (*Cf.* also Cornu, Poincaré, Potier and Berthelot, *Compt. rend.*, cxii.; and Drude, *Wied. Ann.*, xli., xliii.).

as benzoic acid, toluene, turpentine, &c. At a later date this severe method of treatment was replaced by the milder action of fused potash, with the result that a number of new aromatic acids and phenols were discovered. At the present time the separation of the various constituents of a resin is effected by the use of solvents and the numerous reagents which the resources of modern organic chemistry can offer. The results do not carry us very far. As the author says, "our march of conquest has only begun, and the present volume may suggest a successful plan of campaign." J. B. C.

The Lepidoptera of the British Islands: a Descriptive Account of the Families, Genera and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits and Localities. By Charles G. Barrett, F.E.S. Vol. vi. Parts 59-70. Heterocera (Noctuina—Geometrina). Pp. 388. Plates 233-280. (London: Lovell, Reeve and Co., Ltd., 1900.)

THE present instalment of Mr. Barrett's great work includes 110 species, from *Hoporina croceago*, Schiff., to *Halix wauaria*, L., and is written in the same exhaustive manner as previous volumes, giving all the information that a collector of British Lepidoptera (as such) is most likely to require. To Continental entomologists who wish to acquire an accurate knowledge of our limited insular fauna it would also prove very useful; though it is to be regretted that the bulk of the book, which may be expected to extend to nearly twenty volumes, and the unavoidable costliness of the larger edition issued with plates (which are not included in the cheap edition), must necessarily tend to restrict the sale. Those requiring it may therefore be recommended to obtain it volume by volume, or in monthly parts, as it appears, rather than to wait till the whole work is completed. We need not repeat our comments on earlier volumes, which will equally apply to the one before us; but the accounts given of the habits of the various moths discussed are always interesting, and sometimes curious; thus we learn that the rare *Cerastis erythrocephala*, Schiff., after its discovery in 1847, was met with occasionally till 1859, when it seems to have almost disappeared till 1872 and 1873, since when only one specimen, taken in 1894, has been found in England. The periodicity of the appearance of many species in these islands is curious, and has never been fully explained, for the causes which appear applicable to some cases will not explain others; and, moreover, uncertainty in the appearance of species seems to increase rather than to diminish. English names are not a conspicuous feature in this book, but Mr. Barrett notes that a recent writer has called *Xylina conformis*, Schiff., "The Conformist," and the next species, *X. lambda*, Fab., "The Nonconformist"! The resemblance of species of *Calocampa* and *Cucullia* to bits of stick is commented on; in fact, certain moths and larvæ thus fill the gap in our protected fauna caused by the absence of the stick insects proper, or Phasmidæ, which are not found nearer to our shores than the South of France. Several species noted in this volume seem to be now extinct in our islands; thus, *Chariclea delphinii*, L., does not seem to have been taken in England since about 1815. Their place has been taken by others; for example, the northern migration of *Plusia moneta*, Fab., reached England in 1890, and is probably still extending. Other moths of interest are those with cannibal larvæ, such as *Scopelosoma satellitia*, L., *Heliothis armigera*, Hübn., &c. There are many other interesting observations, which we have no room to quote, in the present volume, comprising, as it does, the conclusion of the Noctuæ, the Deltoidæ, and the first few species of the Geometræ. We may, however, note that the enigmatical *Sarrothripa revayana*, Schiff., is regarded by Mr. Barrett as a true *Noctua*, and is placed at the end of the *Noctuae Trifidae*.

W. F. K.

LETTER TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Plankton of the Bay of Biscay.

WITH the valuable assistance of Mr. L. A. Borradaile, of Selwyn College, Cambridge, I have just completed a series of observations on the plankton of the Bay of Biscay extending over about three weeks, by means of opening and closing nets, as well as ordinary tow-nets. Our observations point to the fact (unexpected at any rate by myself) that the smaller Mesoplankton practically ceases at a depth of about 1000 fathoms. This conclusion agrees with that reached by Prof. Chun on the basis of the *Valdivia* Expedition (Deutsche Tiefsee Expedition, 1898-99, p. 44), with which, however, we were unacquainted until we had arrived at it independently. Below this limit we almost always captured a few specimens, as to which it was doubtful whether they were alive when captured, or were merely corpses of a shallower fauna sinking to the bottom, but in a few cases we at present incline to assign them to a living Mesoplankton.

We have also taken about 90 hauls under varied conditions at varied depths between 100 fathoms and the surface, which will eventually, we hope, give a fairly accurate basis for the determination of the vertical movements of the Epiplankton.

Our thanks are due to the Lords Commissioners of the Admiralty for placing the ship at our disposal, and to Captain Field and the other officers of the *Research* for their ungrudging assistance. G. HERBERT FOWLER.

H.M.S. *Research*, Devonport, July 27.

THE TEACHING OF MATHEMATICS.

I THINK it very important to try to get a view of our system of teaching mathematics which is not too much tinted with the pleasant memories of one's youth. Like all the men who arrogate to themselves the right to preach on this subject, I was in my youth a keen geometrician, loving Euclid and abstract reasoning. But I have taught mathematics to the average boy at a public school, and this has enabled me to get a new view. I have seen faces bright outside my room become covered as with a thin film of dulness as they entered; I have known men, the best of their year in England in classics, lose in half an hour (as men did in the first day of slavery in old times) half their feeling of manhood; and I have known that, as an orthodox teacher of mathematics, I was really doing my best to destroy young souls. Happily, our English boys instinctively take to athletics as a remedy, and I know of nothing which gives greater proof of the inherent strength, in good instincts and common sense, of our race than this refusal to allow one's soul to be utterly destroyed. I have also mixed much with engineers, who really need some mathematics in their daily work, men who say that they once were taught mathematics, and I know that these men never use anything more advanced than arithmetic, and actually loathe a mathematical expression when it intrudes itself into a paper read before an engineering society. Of all branches of engineering, electrical engineering relies most upon exact calculation. Well, the average electrical engineer in good practice would rather work a week at many separate arithmetical examples than try for an hour to get out the simple algebraic expression, which includes all his week's results and much more. Yet he has passed perhaps certain rather advanced examinations in mathematics. Furthermore, those engineers who can most readily apply mathematics to engineering problems, almost invariably descend to the position of teachers and professors in schools and colleges, and they seem to lose touch completely with the actual life of their profession.

I have studied these phenomena very carefully, and I affirm that they are directly traceable to the absurd thing called mathematical teaching in schools and colleges.

The framers of educational methods took in their youth to abstract reasoning as a duck takes to water, and of course they assume that a boy who cannot in one year understand a little Euclid must be stupid. In truth, it is a very exceptional mind, and not, perhaps, a very healthy mind, which can learn things or train itself through abstract reasoning; nor, indeed, is much ever learnt in this way. Do we philosophise about swimming before we know how to swim; or about walking or jumping, or cycling or riding a horse, or planing wood, or chipping or filing metals, or about playing billiards or cricket? Is it through philosophy that we learn a game of cards, or to read or to write? No; we first learn by actual trial; we practice as our mind lets us; we philosophise afterwards—perhaps long afterwards. Then if we are too clever or stupid, we insist on teaching a pupil from the point of view which we have at the end of our studies, and we refuse to look at things from the pupil's point of view.

What a natural but ghastly statement the boy made who said: "Yes, Euclid and Xenophon, the beasts, wrote books for the third and fourth forms"! It is even a ghastlier notion that the jokesomeness of a philosopher, the unessential fringe of a subject, often becomes the soul-destroying, weary, worrying study of a schoolboy.

In a short article I shall not attempt to put forward my views as to how mathematics ought to be taught; I have published some of them in a summary of lectures on "Practical Mathematics," published by the Science and Art Department, and in my "Calculus for Engineers."

We let a Board School boy jump over all the ancient philosophy of arithmetic with its twenty-seven independent Greek characters (for our ten figures), the study of which required a lifetime, so that only old men could do multiplication, and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day it could not be remembered. Why not also let a boy jump over all the Euclidian philosophy of geometry, and assume even the forty-seventh proposition of the first book of Euclid to be true? Why not let him replace the second and fifth books of Euclid by a page of simple algebra, and give him much of the sixth book as axiomatic? If you must insist on abstract reasoning, you had better remember that nothing is really axiomatic; but any well-established truths may be looked upon as fundamental or axiomatic, and a system of abstract reasoning may be founded upon them. At present, a man at Cambridge finishes just where the really interesting and useful part of mathematics begins. There would not indeed be much difficulty in framing a course in which he would begin by studies where the studies of good mathematicians now end. This has been tried and proved successful. The present rules of the game are really a little too absurd. A difficult vector subject like geometry must be studied before algebra. Simple exercises on squared paper, well within the capacity of even illiterate persons, must not be approached until one has wasted years on higher algebra and trigonometry and geometrical conics, because they belong to the subject of co-ordinate geometry. It is assumed that it is not until after co-ordinate geometry is thoroughly studied that a man can take in the idea which underlies the calculus, an idea which is possessed by every young boy with absolute accuracy, and by every healthy mind.

Some friends of mine assert that no boy or man ought to be allowed to use logarithms until he knows how to calculate logarithms. They say this, knowing that the calculation is a branch of what is called higher mathematics, and that the average schoolboy, after six years at mathematics, finds it hopeless to even begin the study of the exponential theorem. It is a hard saying! It is exactly like saying that a boy must not wear a watch or a pair of trousers until he is able to make a watch or a pair of trousers. I am an advocate for the use by all students of all appliances which may be useful to them, whether made by tailors, or watchmakers, or instrument makers, or builders, or pure mathematicians. We need not believe a craftsman when he tells us that we cannot utilise his results without practising his trade. Nevertheless, it is good to be able to do some things for one's self, such as sewing on buttons, or using the lathe or a blowpipe, or the development of a little mathematics. If readers will refer to the above-mentioned *summary* they will see that I consider a good system of mathematics teaching of fundamental importance in the education of all men.

I must not dwell any longer on the imperfections of the existing system, but I hope that even readers who do not quite agree with me that much of the sixth book of Euclid ought to be regarded as axiomatic, will agree that what we usually call arithmetic is useless. For races not troubled with our abominable system of weights and measures, the whole of arithmetic consists merely of multiplication and division. To them a decimal is no more difficult to understand than an ordinary number. It is supposed that an English boy understands at once the meaning of 4,590,000 or 4590 or 459, but that such a number as 45·9 or ·459 or ·00459 is beyond his comprehension. I say that this is a difficulty artificially maintained by our stupid methods of teaching. Like the rest of our stupid methods, it is due to our unscientific ways of thinking. Because the embryo passes through all the stages of development of its ancestors, a boy of the nineteenth century must be taught according to all the systems ever in use and in the same order of time. The decimal system of stating numbers is 700 years old in Europe, but it was not till 280 years ago that Napier invented the use of decimals and the decimal point. Think of compelling all emigrants to pass to America through Cuba, because Cuba was discovered first. Think of making boys learn Latin and Greek before they can write English, because Latin and Greek were the only languages in which there was a literature known to Englishmen 450 years ago.

Again, the ingenious teachers of last century incorporated every kind of arithmetical example in a book and called each kind by a slang name—practice, interest, discount, tare and tret, alligation, position, &c., and we must teach exactly as they did. I do not mind retaining the buttons at the back of my coat; many useless ancient ceremonies may still be practised, and I shall not object. I can even admire them, but the unscientific waste of the valuable youth of millions of our people, now that we are face to face with nations who are determined to destroy England through commerce and war, is so abhorent to me that I cannot think of it with patience. It is not merely in arithmetic and geometry, but in the higher parts of mathematics that this waste goes on. Newton employed geometrical conics in his astronomical studies, and mechanics was developed; and therefore it is that every young engineer must study mechanics through astronomy, and he dare not think of the differential calculus till he has finished geometrical conics. The young applier of physics, the engineer, needs a teaching of mathematics which will make his mathematical knowledge part of his mental machinery, which he shall use as readily and certainly as a bird uses its wings; and we teach him in such a way that he hates the sight of a mathematical symbol all his life after.

It is just as in classics. Ask the average man if he ever reads anything now in Latin or Greek; ask him about anything to which he devoted ten years of his

study at school, and he will answer that the only men he knows of who read the classics are a few famous scholars and the cads who read with delight cribs of the *Odyssey* and the *Iliad* just as if they were novels, because they never had the advantage of a classical education. But, of course, his mind was trained, he can always say that.

The authorities of the Science and Art Department recognise that apprentices and others attending evening classes may possibly benefit by a course of study very different from what is necessary if students are being prepared for university and other examinations. Hence, in addition to their very complete orthodox courses of instruction, they recognise the new method of study, the most elementary part of which is beginning to get crystallised in the following syllabus. There is also an "Advanced" syllabus, which is too long to be published here. I would advise interested persons to write to the Department for copies, and also for the report on the result of last year's examination, as well as for copies of the examination papers and of the above-mentioned summary.

I venture to hope for criticism of this syllabus—first, from men like my Cambridge friends, who are quite sympathetic, but who think the method one fit for evening classes only; second, from men who think with me that the method is one which may be adopted in every school in the country, and adopted even with the one or two boys in a thousand who are likely to become able mathematicians; third, from other men. Whatever be the point of view of any critic, he must surely feel that exhaustive criticism is important, for there are many large technical schools in England in which the method has already been adopted, the orthodox system being quite given up. I have been informed that the method is spreading rapidly in Germany also. I can already see from the exceedingly interesting examination results that crystallisation is proceeding rapidly, and if criticism is to be of value, now is the time for it. I hope also that the seemingly bumptious manner in which I criticise orthodox methods of teaching will not induce contemptuous indifference in men of thought. I hold a brief in the interests of average boys and men; my strong language and possible excess of zeal are due to the fact that nearly all the clever men have briefs on the other side.

JOHN PERRY.

PRACTICAL MATHEMATICS.

ELEMENTARY STAGE.

Arithmetic.—The use of decimals; the fallacy of retaining more figures than are justifiable in calculations involving numbers which represent observed or measured quantities. Contracted and approximate methods of multiplying and dividing numbers whereby all unnecessary figures may be omitted. Using rough checks in arithmetical work, especially with regard to the position of the decimal point.

The use of $5{\cdot}204 \times 10^5$ for 520400 and of $5{\cdot}204 \times 10^{-3}$ for ·005204. The meaning of a common logarithm; the use of logarithms in making calculations involving multiplication, division, involution and evolution. Calculation of numerical values from all sorts of formulæ.

The principle underlying the construction and method of using a common slide rule; the use of a slide rule in making calculations. Conversion of common logarithms into Napierian logarithms. The calculation of square roots by the ordinary arithmetical method. Using algebraic formulæ in working questions on ratio and variation.

Algebra.—To understand any formula so as to be able to use it if numerical values are given for the various quantities. Rules of Indices.

Being told in words how to deal arithmetically with a quantity, to be able to state the matter algebraically. Problems leading to easy equations in one or two unknowns. Easy transformations and simplifications of formulæ. The determination of the numerical values of constants in equations of known form, when particular values of the variables are given. The meaning of the expression "A varies as B."

Factors of such expressions as $x^2 - a^2$, $x^2 + 11x + 30$, $x^2 - 5x - 66$.

Mensuration.—The rule for the length of the circumference of a circle. The rules for the areas of a triangle, rectangle, parallelogram, circle; areas of the surfaces of a right circular cylinder, right circular cone, sphere, circular anchor ring. The determination of the area of an irregular plane figure (1) by using a planimeter; (2) by using Simpson's or other well-known rules for the case where a number of equidistant ordinates or widths are given; (3) by the use of squared paper whether the given ordinates or widths are equidistant or not, the "mid-ordinate rule" being used. Determination of volumes of a prism or cylinder, cone, sphere, circular anchor ring.

The determination of the volume of an irregular solid by each of the *three* methods for an irregular area, the process being first to obtain an irregular plane figure in which the varying *ordinates* or widths represent the varying *cross sections* of the solid.

Some practical methods of finding areas and volumes. Determination of weights from volumes when densities are given.

Stating a mensuration rule as an algebraic formula. In such a formula any one of the quantities may be the unknown one, the others being known.

Use of Squared Paper.—The use of squared paper by merchants and others to show at a glance the rise and fall of prices, of temperature, of the tide, &c. The use of squared paper should be illustrated by the working of many kinds of exercises, but it should be pointed out that there is a general idea underlying them all. The following may be mentioned:—

Plotting of statistics of any kind whatsoever, of general or special interest. What such curves teach. Rates of increase.

Interpolation, or the finding of probable intermediate values. Probable errors of observation. Forming complete price lists by shopkeepers. The calculation of a table of logarithms. Finding an average value. Areas and volumes, as explained above. The method of fixing the position of a point in a plane; the x and y and also the r and θ, co-ordinates of a point. Plotting of functions, such as $y = ax^n$, $y = ae^{bx}$, where a, b, n, may have all sorts of values. The straight line. Determination of maximum aud minimum values. The solution of equations. Very clear notions of what we mean by the roots of equations may be obtained by the use of squared paper. Rates of increase. Speed of a body. Determination of laws which exist between observed quantities, especially of linear laws. Corrections for errors of observation when the plotted quantities are the results of experiment.

In all the work on squared paper a student should be made to understand that an exercise is not completed until the scales and the names of the plotted quantities are clearly indicated on the paper. Also that those scales should be avoided which are obviously inconvenient. Finally, the scales should be chosen so that the plotted figure shall occupy the greater part of the sheet of paper; at any rate, the figure should not be crowded in one corner of the paper.

Geometry.—Dividing lines into parts in given proportions, and other illustrations of the 6th Book of Euclid. Measurement of angles in degrees and radians. The definitions of the sine, cosine and tangent of an angle; determination of their values by drawing and measurement; setting out of angles by means of a protractor when they are given in degrees or radians, also when the value of the sine, cosine or tangent is given. Use of tables of sines, cosines and tangents. The solution of a right angled triangle by calculation and by drawing to scale. The construction of a triangle from given data; determination of the area of a triangle. The more important propositions of Euclid may be illustrated by actual drawing; if the proposition is about angles, these may be measured by means of a protractor; or if it refers to the equality of lines, areas or ratios, lengths may be measured by a scale and the necessary calculations made arithmetically. This combination of drawing and arithmetical calculation may be freely used to *illustrate* the truth of a proposition.

The method of representing the position of a point in space by its distances from three co-ordinate planes. How the angles are measured between (1) a line and plane; (2) two planes. The angle between two lines has a meaning whether they do or do not meet. What is meant by the projection of a line or a

plane figure on a plane. Plan and elevation of a line which is inclined at given angles to the co-ordinate planes. The meaning of the terms "trace of a line," "trace of a plane."

The difference between a *scalar* quantity and a *vector* quantity. Addition and subtraction of vectors.

Slope of a line; slope of a curve at any point in it. Rate of increase of one quantity y relatively to the increase of another quantity x; the symbol for this rate of increase, namely, $\frac{dy}{dx}$; how to determine $\frac{dy}{dx}$ when the law connecting x and y is of the form $y = ax^n$. Easy exercises on this rule.

In setting out the above syllabus the items have been arranged under the various branches of the subject.

It will be obvious that it is not intended that these should be studied in the order in which they appear; the teacher will arrange a mixed course such as seems to him best for the class of students with whom he has to deal.

ANALYTICAL PORTRAITURE.

IT seems well to put on record the principal results of experiments that I have recently made to *isolate the particulars* in which one portrait differs from another. They had a measure of success, but not enough to deserve illustration or lengthy description. The objects I had hoped to attain are important; namely, to define photographically the direction and degrees in which any individual differs from the race to which he belongs, the race being represented by a composite picture of many individuals belonging to it. Or, again, to define the particulars in which any variety of a plant or animal differs from its parent species. Or to define family features; or to isolate expressions, recollecting that these consist both of subtractions from, and additions to, the features as seen in repose.

My starting point was that the exact superimposition of a rather faint positive upon its rather faint negative produces an approximately uniform grey, when they are viewed as a single transparency. Thus, I photographed a rotating disc that had been faced with white paper and divided into concentric rings. The innermost disc was left white, the outermost ring was painted black, and the intermediate rings contained successively increasing proportions of black to white. The photographic negative showed rings of graded tints, and from this I took a positive by contact. Subsequently applying the positive to the negative, film to film, and viewing them as a transparency, a nearly uniform grey surface was produced. It was necessary to superimpose them with exactness; otherwise the edges of the rings were conspicuously dark in one part, and light in the opposite part. Another test experiment was to paste together thicknesses of tracing paper—two-fold, three-fold, &c., up to twelve-fold—to cut distinctively shaped snippets of these and to variously distribute them over the surface of a glass plate, which was then photographed, and a positive taken as well. On treating the positive and negative as above, all the tints between those of the three-fold and the nine-fold inclusive produced a uniform grey.

Let A and B be any two pictures whose respective negatives and positives will be called *neg. a*, *pos. a*, *neg. b*, *pos. b*. My object was to produce photographically a third pictue X which should express the difference between A and B; that is, should be equal to A—B, or else a fourth picture Y which should represent B—A.

It will, however, be simpler to treat the problem at first as an optical one, based on the following equations:—

$$\text{(I.)}\ \textit{pos. } a + \textit{neg. } a = \textit{grey}\,;\ \text{(II.)}\ \textit{pos. } a + x = \textit{pos. } b$$

(if treated as a photographic problem, (II.) would be replaced by *pos.* $a + x =$ *neg.* b). From these we obtain

$$\text{(III.)}\ \textit{pos. } a + \{\textit{pos. } b + \textit{neg. } a\} = \textit{pos. } b + \textit{grey}$$

and

$$\text{(IV.)}\ \textit{pos. } b + \{\textit{pos. } a + \textit{neg. } b\} = \textit{pos. } a + \textit{grey}.$$

Calling the terms within brackets by the name of "transformers," the transformer of b into a is the negative of the transformer of a into b. The two terms within brackets may be "composited" together on equal terms, then the result may be composited with the first term, allowing two-thirds of the total time of exposure to the transformer, and one-third to the first term. Or, what comes to the same thing in the end, all three terms may be composited in equal shares, allowing one-third of the total time of exposure to each. The transformers in (III.) and (IV.) being respectively x + *grey* and y + *grey*, are nearly equivalent for the purposes of the inquiry to x and y, because the addition of a uniform shade of grey has little or no effect on pictorial resemblance. A portrait does not cease to resemble the original when it has become somewhat browned by exposure to a London atmosphere, or when it is viewed in shade, or under a tinted glass. Its distinctiveness depends on the *differences* (not the ratios) being preserved between the tints of all adjacent elements of its surface. Of course the grey must not be too dark; otherwise the deeper tints of the portrait would appear indistinguishably black.

This method of transformation succeeds fairly well. I changed an **F** on a white ground into a good **G** on a grey ground, and I changed with passable success one portrait A on white ground into another portrait B on grey ground, but the transformer itself gave little of that information to the eye which I had expected. It *must* have nearly isolated, but it failed to exhibit in an intelligible form the differences between A and B. Then I photographed two faces, each in two expressions, the one glum and the other smiling broadly. I could turn the glum face into the smiling one, or *vice versa*, by means of the suitable transformer; but the transformers themselves were ghastly to look at, and did not at all give the impression of a detached smile or of a detached glumness.

Part of the ghastliness was due to the different densities of the superimposed positives and negatives, which did not neatly obliterate one another in the unchanged portions of the face, and part was due to their not being superimposed in the best possible way. There can be no doubt of the best fit when engaged in making the transformer of an **I** into an **L**; but the eye must determine the best fit and proportions of the two components of the transformer of one portrait into another. I cannot yet make up my mind whether or no the process admits of substantial improvement, but feel sure that the only satisfactory experiments now would be those made by two converging lanterns on a screen, one at least of which admits of easy and delicate adjustment in direction and in the intensity of its illumination. The most suitable portraits for the attempt are apparently such as are popularly, and sometimes reproachfully, termed "artistic," that is to say, with blurred outlines and medium tints; certainly not those which in photographic language are called "plucky." I have no means in my house for experiments of this kind, but perhaps a trial might be made in some laboratory where they exist. The point is to ascertain whether the images of *neg. a* and *pos. b* can be so combined on the screen as to give an intelligible and useful idea of the differences between A and B.

FRANCIS GALTON.

A RECOLLECTION OF KING UMBERTO.

HOW enthusiastically the late King of Italy could devote himself to the welfare of science and art, those of us who were at Como last September had an opportunity of seeing. One very hot day he arrived with the Queen and the Duke of Naples by train from their palace at Monza, near Milan. First they made an official inspection of the galleries and machinery in the Silk and Electricity Exhibition, then they visited the Exhibition of Sacred Art, and, after lunch, they opened

the Electrical Congress, held to celebrate the Volta centenary.

This was a no mere regal opening occupying a fraction of an hour, for a solid afternoon's work was done in receiving various addresses and listening to a long lecture on Volta and his pile, in which Volta's work was described at length, and even discussed from the modern standpoint of the ionic theory of voltaic action. Finally, the king had several foreigners presented to him, and he chatted with us about the things in which *we* were interested.

But even this was not enough for one day's work, since, before leaving, the Royal party went to the cathedral to listen to the new oratorio, *The Nativity*, which was exciting so much interest in Como at that time.

Such a keen personal interest in science and art made the king much loved by a people who venerate even the tomb of a worker like Volta. And those of us who saw King Umberto only at Como last year feel that it is not merely a king, but a friend who has now been killed.

W. E. AYRTON.

NOTES.

ON Monday next, August 6, the International Congress of Physics will be opened at Paris with an address by the president, Prof. Cornu. The Congress will then be divided into the seven following sections, which will meet in the rooms of the Société française de Physique: (1) general questions, instruction, measurements; (2) mechanical and molecular physics; (3) optics; (4) electricity and magnetism; (5) magneto-optics, radio-activity, discharges in gases; (6) cosmical physics; (7) biological physics. As many of our readers are aware, much attention has been given to the organisation of the Congress. The secretaries of the committee, Prof. Poincaré and Dr. Guillaume, have been entrusted with the production of three volumes, already in the press, containing more than seventy reports on physical questions of current interest and importance, contributed by physicists of various nationalities. Among the subjects dealt with by British physicists are: the movements produced in an indefinite solid by the displacement of a material body, by Lord Kelvin; the constant of gravitation, by Mr. C. V. Boys; the propagation of electricity, by Prof. Poynting; electric discharges in gases, by Prof. J. J. Thomson; properties of alloys, by Sir W. C. Roberts-Austen; and the unit of heat, by Mr. E. H. Griffiths. In addition there are contributions by Profs. Lorentz, van 't Hoff, Warburg, Voigt, van der Waals, H. Poincaré, Cornu, Lippmann, Potier, Becquerel, Arrhénius, Exner, Spring and others. The sectional meetings will partly be held simultaneously and partly at different hours, in order to give members an opportunity of hearing papers of interest to all physicists. In addition to the serious work of the Congress, provision has been made for lighter entertainment. The Municipal Council of Paris will hold a reception on Tuesday, August 7, and the French President will give a reception to the members on August 9. Prince Roland Bonaparte will give a soirée on August 11, and in his splendid library an exhibition of new apparatus and experiments will be held. There is thus every promise that the meeting will be both interesting and pleasant to all who are able to take part in it.

IT is announced that permission has been granted for the Institution of Electrical Engineers to hold a reception in the British Royal Pavilion in the Paris Exhibition from 5 to 7 p.m., on Wednesday, August 22, and that arrangements for the reception are being made accordingly.

WE learn from *Science* that the New York Board of Estimate and Apportionment has authorised the expenditure of 200,000 dollars for the Botanical Garden, and 150,000 dollars for an addition to the American Museum of Natural History.

MR. LEONARD S. LOAT, who is investigating the fishes of Egypt for the British Museum and the Egyptian Government, was last heard of at Korti, where he reports (on May 18) a hot wind and a temperature of 115° in the shade. He had sent home upwards of 2200 specimens of Nile-fishes to the Natural History Museum, and as soon as the river had risen sufficiently would proceed to Senaar and Khartoum.

MR. J. S. BUDGETT, who is engaged in collecting fishes on the River Gambia, dates his last letters (June 22) from McCarthy's Island in the interior. There had been a disturbance in the colony, and one of the Commissioners and a party of police were believed to have lost their lives; but this had not affected Mr. Budgett's operations, and he had a large number of Polypteri and Protopteri in floating cages in the river. He was in good health, and expected to be home again in September.

THE Rocky Mountain Goat (*Haploceros montanus*) in the Zoological Society's Gardens has now put on its full white summer dress, and is well worthy of inspection. This animal, until lately, was supposed to be the only representative of the Mountain or Goat-like Antelopes in the New World, but a second species of the same genus has recently been discovered in Alaska, and named by Mr. D. G. Elliott, of Chicago, *Oreamnus kennedyi*. The form is no doubt closely allied to *Nemorhaedus* of the mountain ranges of Asia, and probably found its way to the New World in company with the Rocky Mountain Sheep and Wapiti Deer.

THE *Electrician* states that the German Electro-Chemical Society is arranging to hold its seventh annual meeting at Zürich on August 5-7. In addition to the reading of a number of papers, visits are to be paid to the Polytechnic and to the works of the Oerlikon Co.

THE Moxon gold medal of the Royal College of Physicians, founded in 1886 in memory of the late Dr. Walter Moxon, and awarded every third year for distinction in clinical medicine, has been awarded to Sir William T. Gairdner, K.C.B., F.R.S., Emeritus professor of medicine in the University of Glasgow. Prof. Clifford Allbutt will deliver the Harveian Oration on October 18 (St. Luke's Day); and Dr. A. E. Garrod, the Bradshaw Lecture in November. Dr. Henry Head has been appointed the Goulstonian, Dr. J. Frank Payne the Lumleian, and Dr. Halliburton the Croonian Lecturer for 1901, and Dr. J. W. Washbourn the Croonian Lecturer for 1902.

WE are indebted to Mr. C. Repington, of Bridge End, Ockham, Surrey, for some eggs of the Wood Leopard Moth (*Zeuzera Æsculi*). They resemble strings of small oval beads, of a yellowish testaceous colour. The moth, although reputed scarce, is commoner round London than is generally supposed, and would be very destructive, if its numbers were not kept down by birds, notably by sparrows and woodpeckers. The eggs might be reared by placing them in chinks of the bark of almost any deciduous tree (apple, elm, &c.). The larvæ feed, like those of the Goat Moth (*Cossus ligniperda*), in the wood of growing trees, but are much less common.

QUESTIONS referring to the Marine Biological Association were asked in the House of Commons on Thursday last, and were replied to by Mr. Ritchie as follows:—"In 1885, the Treasury, when agreeing to a grant to the Plymouth laboratory of the Marine Biological Association, made it a condition 'That the council undertakes to place space in the Plymouth laboratory at the disposal of any competent investigator deputed by a recognised authority to carry out any investigation into fish questions for which the laboratory can give facilities.' The Board of Trade have never employed any naturalist to make investigations on fishes at the laboratory, and they have no staff or funds to devote to such a purpose. I have no information as

to what has been done by other Government authorities. The Board of Trade have occasionally consulted the council of the Marine Biological Association on fishery subjects. The latest occasion had reference to the question of a fisheries exhibit at the Paris Exhibition. The inspectors of the Board of Trade have on many occasions consulted the officials of the association in an informal manner. The association were not directly consulted by of the Board Trade as to the Bill dealing with undersized fish, which, however, was founded on the recommendations of the Select Committee of 1893, who took evidence from the association."

THE sixty-eighth annual meeting of the British Medical Association was opened at Ipswich on Tuesday under the Presidency of Dr. W. A. Elliston. An address in medicine was delivered on Wednesday by Dr. Philip Henry Pye-Smith, F.R.S.; an address in surgery will be delivered to-day by Dr. Frederick Treves; and an address in obstetrics will be delivered by Dr. William J. Smyly on Friday. The scientific business of the meeting is being conducted in thirteen sections, as follows, namely: Medicine; surgery; obstetrics and gynæcology; State medicine; psychology; physiology; pathology; ophthalmology; diseases of children; pharmacology and therapeutics; laryngology and otology; tropical diseases; navy, army and ambulance. The exhibits in the annual museum held in connection with the meeting are arranged in the following sections:—Section A: Food and drugs, including prepared foods, chemical and pharmaceutical preparations, &c.; Section B: Instruments, comprising medical and surgical instruments and appliances, electrical instruments, microscopes, &c.; Section C: Books, including diagrams, charts, &c.; Section D: Sanitary appliances and ambulances.

THE address of Mr. E. M. Holmes, the president of the British Pharmaceutical Conference held in London last week, and most of the papers read and discussed at the meetings, are published in full in the current number of the *Pharmaceutical Journal*. Mr. Holmes reviewed the progress of science, so far as it affected pharmacy, during the present century, and indicated some of the changes which have occurred. Referring to the subject of an international Pharmacopœia, he remarked:—"'A General Pharmacopœia, that would enable a pharmacist to dispense a prescription with uniformity in any pharmacy on the Continent, may be regarded as a Utopian rather than a practical idea, and could only be attained by alphabetically arranging in dictionary form all the formulæ in all the known pharmacopœias. But there can be no reason why an approach towards it should not be made by a congress of medical men and pharmacists, limiting their attention, in the first place, to poisonous preparations only, and, in order to avoid international jealousies, adopting as a standard the formulæ that approach nearest to decimal proportions. The comparison of different formulæ is rendered a simple matter by the publication of the different strengths of preparations of the various pharmacopœias in Squire's 'Companion to the British Pharmacopœia.' The next step might be to make uniform the strength of the most generally used preparations that are not poisonous. A really useful International Pharmacopœia cannot be otherwise than a gradual growth."

AMONG the papers printed in the *Pharmaceutical Journal* are several of interest outside pharmaceutical circles. Mr. E. J. Parry shows that the so-called santalol, which exists to the extent of about 90 per cent. in sandal-wood oil, is a mixture of two or more bodies of an alcoholic nature, one of which is that to which the name santalene has been applied. Mr. T. H Wardleworth deals with some pharmaceutical and economic plants of Jamaica. As the result of a visit to that island he is of opinion that pharmacists would do well to attempt to obtain from British colonies supplies of many drugs which at present come from other parts of the world. Messrs. T. Tyrer and A. Levy continue their investigation on melting points, the substances more recently examined being salicylic acid, salol, carbolic acid, menthol, and thymol. Messrs. C. T. Tyrer and A. Wertheimer have made a careful physical examination of American, Russian, and French turpentine oils and terebene made therefrom, and propose, at some future date, to investigate similar products from all possible sources. As a general rule they find that the higher the initial rotation of American turpentine the smaller is the product of inactive mixture capable of steam distillation and the higher the specific gravity. French turpentine has a greater tendency to oxidise than American, being intermediate between that and the Russian oil. Dr. F. B. Power summarises the methods which have been advocated for the preparation of mercurous iodide, and gives the results of determinations of the amount of iodine or pure mercurous iodide contained in specimens of the compound made in different ways. These results indicate that precipitated mercurous iodide is quite uniform in composition and also sufficiently stable when properly protected. Mr. E. Dowzard thinks that useful information may be obtained by determining the viscosity of essential oils. A specimen of pure lemon oil had a viscosity of 139·6, whilst that of citrene was found to be 105·8, and that of a mixture of citrene with 7·5 per cent. of citral was 114·9.

H.M.S. *Viper*, which it will be remembered is driven by the "Parsons' steam turbine system" (built by the patentees at their works at Newcastle for the British Government, and described and illustrated in NATURE of March 1), has this month not only broken her own record of $35\frac{1}{2}$ knots, but proved to possess qualifications equally important in marine engineering. On six consecutive runs (says *Engineering*, July 20) the following speeds were attained:—

Time on measured mile m. s.	Equivalent speed in knots
1 $38\frac{2}{5}$	36·585
1 $41\frac{2}{5}$	35·503
1 37	37·113
1 $38\frac{2}{5}$	36·585
1 37	37·113
1 $39\frac{4}{5}$	36·072

The mean of two runs with and against the tide was 36·845 knots. The Admiralty mean of the six runs over the mile, with and against the tide, was 36·581 knots, which speed was also the mean for the hour's run. The mean revolutions for the hour's run was 1180 per minute. The steam pressure in the turbines ran up to 200 lbs. per square inch, and the mean pressure in the stokeholds was $4\frac{1}{2}$ inches. Another important feature of the trials was that the *Viper* worked up from a speed of 14 knots to 36·585 knots in twenty minutes; almost as much importance is attached to this as to the high speeds attained, both being very valuable considerations in war vessels and cross channel boats. The trials, it is stated, worked without a hitch, and vibration was practically imperceptible in any part of the vessel.

ACCORDING to a writer in the *Times*, several earthquake shocks were felt at Bognor on July 18, between 10 and 11 p.m. Another correspondent suggests that they were merely the reports of the naval salute fired at Cherbourg on the departure of the French President at the times mentioned. The character of the disturbances, as described, certainly bears out this view. Similar movements and rumbling sounds were also observed at Torquay at the same time. Bognor is eighty-nine miles, and Torquay 101 miles, from Cherbourg.

THE Faculty of Sciences of the University of Rome proposes to publish by subscription a complete collection of the works of the late Prof. Eugenio Beltrami. The collection will probably extend to three or four large volumes of 2000 pages in all, and a copy will be sent to subscribers of 2*l.* and upwards. Subscriptions are to be sent to Isaia Sonzogno, secretary of the Scuola d'Applicazione per gli Ingegneri, 5, Piazza San Pietro in Vincoli, Rome.

IN a pamphlet, entitled the "Inidikil System," Mr. A. Lincoln Hyde suggests a decimal system of weights and measures for the English speaking people based on taking the inch as the fundamental unit. One of the author's main arguments for the proposal appears to be the failure of the metric system to obtain public favour in Great Britain and America, and he therefore thinks it desirable to make another attempt at decimalising our weights and measures.

IN the *Proceedings* of the Rochester Academy of Sciences, vol. iii. Brochure 2, Prof. Arthur L. Baker gives a general summary of vector analysis, and a short note on the graphic representation of imaginaries—both suitable for teaching purposes.

PART 13 of the *Rendiconti del R. Istituto Lombardo* contains two mathematical papers—one by Dr. Duilio Gigli, on helicoidal and ruled surfaces in elliptic space; the other by Signor U. Amaldi, on commutative linear substitutions. In the former, Dr. Gigli, starting with the classical methods of Beltrami, deduces certain theorems relating to ruled surfaces in space of constant curvature, exactly analogous to those known to exist in Euclidean space. The second paper deals with certain generalisations enunciated by Schlesinger in his note, "Ueber vertauschbare lineare Substitutionen" (Crelle, 1899), to which Amaldi applies certain synthetic methods due to Prof. Pincherle.

IN connection with the view that phosphorescence is due to movements of the ether determined by the vibrations of material particles, much interest attaches to the question as to whether the intensity of phosphorescence is modified by a magnetic field. Some experiments described by M. Alexandre de Hemptinne in the *Bulletin de la Classe des Sciences* (Brussels) appear to answer this question in the negative. In one experiment the phosphorescent substance was contained in a tube about 30 cm. long, placed between the poles of an electro-magnet. The middle part of the tube was thus submitted to a field of about 30,000 C.G.S. units, while at the ends the magnetic force was comparatively feeble. The tube contained sulphide of calcium or of zinc, prepared after Becquerel's methods, and it was excited by being exposed to the sun. On observing the tube in a dark room it was seen to be uniformly phosphorescent throughout its length; it remained phosphorescent for a considerable time, and gradually the intensity diminished, but at no stage of the experiment was any difference of intensity noticeable from one end of the tube to the other. In order to make more exact observations, M. de Hemptinne constructed a phosphoroscope of sufficiently large dimensions to contain an electro-magnet. Although this method was much more sensitive than the preceding one, not the slightest difference could be observed in the behaviour of sulphide of lime, sulphide of zinc, nitrate of uranium, diamond and other more or less phosphorescent substances when submitted to a magnetic field of about 32,000 units.

HIGH summer temperatures have continued to prevail over the southern portion of our islands, but there has been an absence of the excessive heat which was experienced in the preceding week. Heavy thunderstorms occurred over a large part of England on July 27, resulting in a fairly heavy rain over London and smaller amounts in many parts of the country. Two quite separate storms passed over the metropolis, one in the afternoon and the second late in the evening. The lightning flashes were very frequent and unusually brilliant. At Greenwich, the rainfall accompanying the thunderstorms measured 0·84 inch, while in Westminster it only amounted to 0·42 inch. The weather has been generally cooler since the storms, although the thermometer in the south of England is well above the average. The mean temperature for July was 4° above the average at Greenwich; the mean of the maxima was 78°, and of the minima, or night readings, 57°. The total rainfall for the month at Greenwich was 1·41 inches, which is more than an inch less than the average.

A PAMPHLET on the organisation of the meteorological service in Japan has been published by the Tokio Observatory, for presentation to the Paris Exhibition. This service, which is very complete, consists of eighty stations of the first and second orders, and of about 900 stations at which only rainfall or temperature is recorded. The departmental stations, in accordance with the decree establishing the service, are established in suitable places, chosen by the Ministry of Public Instruction, and any persons wishing to establish additional stations have to obtain the authority of that Ministry. Electrical, earthquake, and other exceptional phenomena are regularly observed, in addition to the usual meteorological observations. All vessels belonging either to the imperial or merchant service, which are over 100 tons burden, are compelled to make observations at regular intervals, six times daily, and the logs are forwarded to the central observatory. There is also a regular service of weather telegraphy and storm warnings. The observations made three times daily are published in *Weather Reports*, together with forecasts for the following day. The average success of these forecasts amounts to 82 per cent., and of the storm warnings to 70 per cent. In addition to the *Daily Weather Report*, monthly and yearly bulletins are issued; these are naturally written in the Japanese language, but an English translation of the titles and important phrases is added. The present director of the service is Prof. K. Nakamura, graduate of the Tokio University; the staff and attendants of the central observatory amount to fifty-three in number.

THE ethnology of ancient history, deduced from records, monuments and coins, is a subject in which M. Charles de Ujfalvy has made some important investigations. In *l'Anthropologie*, tome ix., he has published a memoir on the White Huns. The Huns artificially deformed their heads so as to greatly increase their height (*déformation relevée* of Broca). They were nearly related to the Hoa of the Chinese annals (which name is merely the origin of the word Hun), to the Yé-tha of the Chinese (who must not be confounded with the very different Yué-tchi), and to the White Huns or Ephthalites of Byzantine and Armenian authors. The Hûna kings of India practised the same cranial deformation, as is shown by their effigies represented on their coinage. The Ephthalites practised polyandric customs, and their women wore special horned head dresses. Traces of polyandric habits, as well as of these extraordinary coiffures, are still to be met with, after more than twelve hundred years, in certain regions of the old Ephthalitic empire.

THE second part of vol. xxviii. of the *Morphologisches Jahrbuch* is entirely taken up by two profusely illustrated memoirs on the morphological anatomy of Vertebrates. In the first of these Dr. S. Paulli continues his elaborate investigations into the extent and form of the air-chambers in the mammalian skull; dealing in this section with the morphology of the ethmoid bone and the relations of the aforesaid chambers in Ungulates. Perhaps the most striking feature in this communication is the labour expended in working out the details of the labyrinth

formed by the ethmoid and surrounding structures, as is well displayed in the text-figures, which resemble puzzles of an unusually complex type. Very unexpected is the discovery that the structure of the ethmoid divides the more typical Ungulates into two groups, one represented by the Ruminants and the other by the Suina and the Perissodactyla. As this grouping so completely traverses the classification indicated by other parts of the organisation, it may be that the feature in question is purely adaptive. In the general structure of the ethmoid the elephant resembles more typical Ungulates. The second of the abovementioned memoirs is a continuation of Dr. B. Haller's study of the Vertebrate brain; the present section dealing with the Pond-Tortoise (*Emys orbicularis*). At the conclusion of his paper the author refers to the structural resemblances between the reptilian brain on the one hand and that of Monotremes and Marsupials on the other. He is led to conclude that a commissure connecting the hemispheres of the brain was developed in an extinct forerunner of the reptiles, which formed the ancestral type of both the Sauropsida and the Mammalia.

TWENTY years ago the late Dr. Dobson described a new species of Australian bat, remarkable for its white head and lower surface of the body, under the name of *Megaderma gigas*. From that time to this the species has been known solely by the type specimen—a male. In No. 7, vol. iii. of the *Records* of the Australian Museum, Mr. E. R. Waite describes a second example, this time a female, obtained in West Australia. To the same journal Mr. Waite likewise contributes a paper on additions to the fish-fauna of Lord Howe Island, in the course of which he describes four new species, one of them being assigned to a new genus. Several of them belong to the coral-eating Chætodonts. The author draws attention to the circumstance that since the transparent larval form to which the name Leptocephalus was assigned in 1763 is now ascertained to be the young of the Conger-eel, the generic title Conger has to give place to Leptocephalus. As this latter name is now no longer available for other similar larvæ of which the adults are unknown, he adopts for them the name Atopoichthys, lately proposed by Garman.

THE July number of the *Biologische Centralblatt* contains an interesting note by Dr. R. Stölzle on the position taken by K. E. von Baer with regard to the origin of the human race. Reference is made to von Baer's opposition to the doctrine of descent from lower animals (1) in pre-Darwinian times; (2) after the appearance of "The Origin of Species"; and (3) after the publication of "The Descent of Man."

CAPTAIN R. H. ELLIOTT, who has been for some time conducting researches into the nature and action of snake venom in India, arrives at the following conclusions in the *British Medical Journal*:—(1) The snakemen of South India are certainly ignorant of any method of producing in themselves a highly-developed condition of immunity. (2) Some few of them appear to practise the swallowing of venom, or the inunction of venom into their limbs, but it is doubtful if they do so with any well-defined object. It is possible that they thus obtain some degree of immunisation. (3) They confine themselves almost exclusively to the cobra, and escape harm by their intimate knowledge of the methods of handling this snake.

A COPY of the second edition of a catalogue of the fossils in the students' stratigraphical series of the Woodwardian Museum, Cambridge, by Mr. H. Woods, has been received.

THE plants collected on the Antillean cruise of the yacht *Utowana*, in Bermuda, Porto Rico, the Caymans, Cozumel, Yucatan, and the Alacran shoals, between December 1898 and March 1899, are described, under the title *Plantae Utowanae*, by Dr. Charles Frederick Millspaugh, in vol. ii. No. 1 of the botanical series of the Field Columbian Museum.

PROF. W. H. CORFIELD's two Harveian lectures on disease and defective house sanitation have been translated into Hungarian by Dr. Frank, of Budapest, for the Royal Society of Public Health of Hungary. Dr. Frank remarks in the preface that the lectures "merit the attention of Hungarian readers because they explain the views of a prominent English hygienist, and also because the sanitary arrangements of dwellings in Hungary are much more unsatisfactory than those in England."

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. W. H. Laws; a Two-spotted Paradoxure (*Naudinia binotata*) from West Africa, presented by Mr. Robert H. Gush; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, four Lorikeets (*Trichoglossus rubritorques*) from North-west Australia, six Roofed Terrapins (*Kachuga tectum*) from British India, two Alligator Terrapins (*Chelydra serpentina*), an American Box Tortoise (*Cistudo carolina*), a Sculptured Terrapin (*Clemmys insculpta*) from North America, deposited; two —— Buntings (*Emberiza sulphurata*) from Japan, purchased; an Altai Deer (*Cervus eustephanus*), three Crested Pigeons (*Ocyphaps lophotes*), a Spotted Pigeon (*Columba maculosa*), four Vinaceous Turtle Doves (*Turtur vinaceus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BORRELLY BROOKS, 1900 *b*.—Several telegrams received from the *Centralstelle* at Kiel announce the appearance of a new comet in the constellation Aries. The following are the positions given:—

1900	R. A. h. m. s.	Decl.	Observer.
July 23d. 12h. 50·0m. (Marseilles Mean Time)	... 2 43 33	... +11° 51′	...Borrelly.
July 23d. 13·00h. (Geneva Mean Time)	... 2 43 40	... +12° 30′	... Brooks.
July 24d. 12h. 57·1m. (Strassburg Mean Time)	... 2 44 26	... +14° 32′ 42″	... Kobold.

A later circular from Kiel furnishes an ephemeris for further observations of the comet, prepared by Herr J. Möller from measures of July 24, 25 and 26.

Elements.

T = 1900 Aug. 3, 298. Berlin Mean Time.

$$\left.\begin{array}{rl} \omega = & 12^\circ\ 30'\cdot 2 \\ \Omega = & 328\ \ 1\cdot 8 \\ \iota = & 62\ \ 35\cdot 6 \end{array}\right\} 1900\cdot 0.$$

$\log q$ = 0·00636

Ephemeris for 12h. Berlin Mean Time.

1900.		R.A. h. m. s.		Decl.		Br
Aug. 1	...	2 53 52	...	+38° 31′·5	...	1·12
3	...	2 57 12	...	44 37·1	...	1·10
5	..	3 1 8	...	50 29·1	...	1·08
7	...	3 5 55	...	56 2·1	...	1·05
9	...	3 11 45	...	+61 11 9	...	0·91

CATALOGUE OF DOUBLE STARS.—The *first* volume (1900) of the *Publications of the Yerkes Observatory* of the University of Chicago has recently been distributed; it contains a list of 1290 double stars, discovered from 1871–1899 by Prof. S. W. Burnham, now on the staff of the Yerkes Observatory. The majority of the measures have hitherto only been published in sections, comprising portions of nineteen different catalogues, and the work of bringing so large a mass of material together was commenced during the author's connection with the Lick Observatory (1888–1892). While working with the large instrument there, many of the more difficult pairs were re-measured, and their positions carefully re-determined by comparison with the newer star catalogues of the *Astronomischen Gesellschaft*, Cordoba, &c., instead of those of Lalande and Argelander. As, however, in the present work no attempt has been made to supersede other star catalogues with respect to the absolute positions, it has not

been thought worth while to bring the co-ordinates past the epoch 1880.

Commencing astronomical observations in 1861 with a very small instrument, Prof. Burnham obtained a six-inch equatorial from Alvan Clark in 1869, with which he commenced systematic work on double stars in 1872. Since that time his observations have been made with instruments of varying aperture, 9·4, 12, 15·5, 16, 18·5, 26, 36 and 40 inches respectively.

Especially interesting is the fact that a great proportion of the pairs discovered have been found to be physically binary, and that these are generally closer and more difficult to measure compared with those in slower motion.

A special list of quadruple stars is given, and various measures have been obtained by the co-operation of other observers with different instrumental equipment. The stars are arranged in order of right ascension; and besides the present elements, a short description of special particulars with comparative previous measures are added to each where necessary, and several illustrations are given of the instruments used in the course of the work.

SOME RESULTS OBTAINED WITH A STORAGE BATTERY OF TWENTY THOUSAND CELLS.[1]

THE remarkable development of practical employments of electricity have put the professor of physics at a disadvantage, compared with the electrical engineer. The latter has at his service thousands of electrical horse-power, while the college instructor can barely obtain fifty. The engineer can experiment with enormously strong currents and study their effects in chemical industries, and in the production of intense heat. Thus the study of the manifestations of electricity on a great scale seems to be relegated to the electrical engineer.

There is one direction, however, in which the university professor can enter into competition with the engineer and even surpass him in resources. This direction is in the field of high electromotive force; and I wish to call your attention to some results which I have obtained with a storage battery of twenty thousand cells. For several years I have had at my command ten thousand cells; and the plant has proved so practical that I resolved last autumn to double the number of cells. The battery is now finished, and you will have an opportunity of seeing its manifestations.

With twenty thousand cells of the Planté type I can obtain forty-two thousand volts, and by the use of Leyden jars I can step up to three million. I cannot go higher, for the very interesting reason that air at atmospheric pressure becomes a fairly good conductor beyond two million volts, and it is impossible to charge Leyden jars to this potential, or to produce sparks in a laboratory of greater length than seven feet. To obtain the greatest manifestations of three million volts, it would be necessary to put the apparatus in an open field at least thirty feet from the ground, and remote from all other objects. Jars and circuits charged to this high voltage emit a luminous discharge to the floor of the room and to the brick walls, and indicate by this inductive discharge the presence of steam pipes twenty feet distant. The air breaks down quickly under this powerful electric stress, and, indeed, acts like a rarified gas.

Nevertheless discharges of electricity six and seven feet long are of interest, especially to many of you who are citizens of Boston, where Benjamin Franklin was born. These discharges closely resemble lightning, and one can reproduce all the photographic effects obtained by students of this astounding natural phenomenon. I have discovered the interesting fact that these long sparks are oscillatory.

The method of proof is this: I connected the condensers which were used in series to produce the high potential of three million volts, in multiple with a known self-induction. The discharge was then photographed. Here is one of the results: The distance between these bead-like figures from centre to centre represents one five-thousandth of a second (Fig 1). When the condensers are connected in series through the same self-induction the discharge still remains oscillatory, but of a much higher period; we are sure of this fact from Lord Kelvin's discussion of the limits of oscillatory action. You will perceive from Fig. 1 that I have been able, by means of the large battery and the large condenser, to photograph comparatively slow oscillations. I have lately succeeded in obtaining photographs of oscillations eight hundred a second; and experiments on the permeability of iron wire with powerful discharges with such low periods are now in progress.

That most discharges of lightning are to-and-fro, or oscillatory, I feel sure, and I have outlined my method of proof; but this was hardly necessary, for the photographs of the long sparks show on mere inspection the to-and-fro motion, for on the line of discharge forks can be observed pointing in opposite directions, showing that the discharge changed from positive to negative. These forks, or branching discharges, have an interesting peculiarity, which was brought out in the following manner. A sheet of plate glass about five feet square was placed between the terminals of the high potential apparatus, and a minute hole was bored in the middle of this plate.

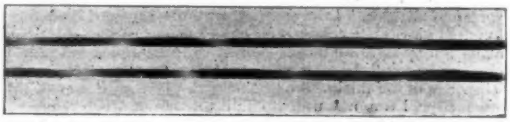

FIG. 1.

This hole could be made very small by plugging the orifice with paraffin, and making needle-holes in the paraffin. When the spark terminals were opposite the hole, each a foot and a-half from it, the spark sought the hole. A photograph of the spark (Fig. 2) shows an apparent breadth of spark much greater than the diameter of the hole; indeed, the minute size of the latter cannot be reproduced on the negative; while the spark seems to the eye to be an eighth of an inch in thickness, and actually measures about a millimetre in diameter on the negative. The reason of this phenomenon, I believe, is that only a portion of the discharge passes through the hole. This can be shown in the following manner. The terminals were not placed opposite the hole, but to one side of it, about a foot from it, and about half a foot from the glass. The discharge then jumped to the glass (Fig. 3), and pursued a devious way to the hole. When the hole was completely filled with paraffin the spark still jumped to the glass, apparently piercing a hole through it; but this was impossible, for the thickness prevented this. The discharge was continued evidently by an inductive action. I next restored the orifice, and, keeping the spark terminals in the last position referred to, I hung a large sheet of paraffined paper

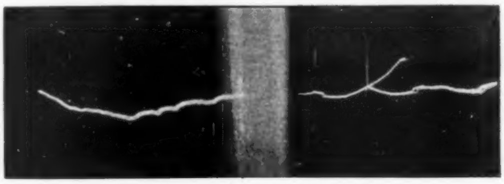

FIG. 2.

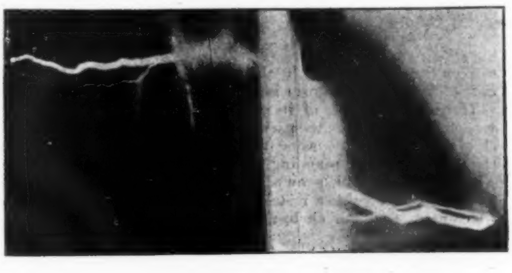

FIG. 3

[1] Paper read by Prof. John Trowbridge at a meeting of the American Academy of Arts and Sciences, held in the Jefferson Physical Laboratory, Harvard University, Cambridge, U.S.

on the glass, and a photograph of the spark was taken. It was found that an explosion occurred at each change in direction of the spark, or at each fork in it. The two effects are shown in Fig. 4 and Fig. 5; and you will see that even the sinuosities are reproduced by a rent in the paper. In the case of a thunder-storm, may not the peculiar rolling of the thunder be due to the successive explosions along the path of a single discharge some hundreds of feet apart?

But I will not dwell longer upon the fascinating study of lightning in a laboratory; for I wish to call your attention to larger fields of inquiry which the possession of this great battery opens. One of the most promising is that of spectrum analysis. In connection with the battery I have three hundred glass plate condensers, one-eighth of an inch thick, and about ten by eighteen inches coated surface; this condenser is charged in multiple to a potential of twenty thousand volts. The glass of the thickness of one-eighth of an inch stands this stress; but I can not use my full voltage of forty thousand, for the glass plates are immediately pierced. To utilise this voltage it will be necessary to employ plates a quarter of an inch in thickness. This is an interesting proof of the large

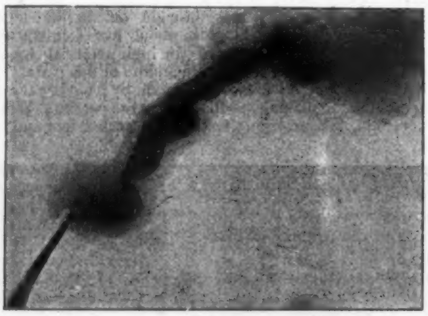

FIG. 4.

FIG 5.

surface density furnished by the battery. The noise of the discharge from this condenser is like the report of a pistol.

Here is an example of its great heating effect. An iron wire was stretched across the spark terminals. This was deflagrated (Fig. 6), while at the same time a spark passed between the terminals. The surrounding air was filled with the scintillating sparks of iron. This shows that it is not impossible that sparks may be formed inside a metallic cage or enclosure; for we can conceive of such an enclosure as a multiple circuit around a spark gap.

By means of the discharge of these condensers charged to a difference of potential of forty thousand volts, I can produce probably the highest degree of instantaneous temperature which has been reached. I have been obtaining instantaneous photographs of the spectra of gases and of the vapour of metals. One discharge, with a Browning direct vision spectroscope, will give a photograph of the spectra of hydrogen, and ten or twelve discharges are sufficient when a short focus grating is employed with a fairly fine slit. I find it desirable to use a peculiar end-on tube for the study of hydrogen. It is of the nature of a Crookes' tube, one end being blown into a very thin bulb; this tube can be heated to a very high temperature during the process of exhaustion to drive out the water vapour.

I have thus submitted hydrogen to a higher temperature than it has been possible to reach before, and the study of the spectra promises to have a bearing on stellar spectra. The advantage of an intense source of light, and consequently of a short time of exposure, is very great; for a large amount of fog is thus escaped, and faint lines come out which escape observation by the comparatively long exposures hitherto necessary.

There is another direction in which this battery can be used, which promises to be of importance in surgery. It furnishes a new source of the X-rays.

The greatest need in the scientific study, and also in the employment of the X-rays in surgery, is a steady source of them. All the methods now in use give a light which is far from constant; the electrical impulses which produce the rays are unequal in strength, and even when they are equal they are generally alternating in character. This to-and-fro action tends to produce a blurring of the shadows, for fluctuating electrical impulses sent through an X-ray tube are apt to give a shifting radiant point.

The ideal method of producing the rays is by the employment of a large storage battery, and I have been working toward this much-desired end during the past two years.

Traces of the X-rays can be obtained with a steady current at a voltage of five thousand; and they are strongly produced at twenty thousand. When forty thousand volts are used with a steady current, the exhibition of rays is surprising; a fluorescent screen is lighted with extreme brilliancy, and marvellous shadows of the bones of the hand are obtained. A steady current is undoubtedly the ideal current for the production of the

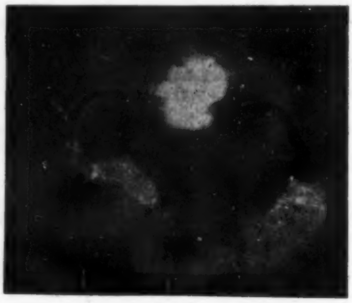

FIG. 6.

X-rays; for the radiant point of the rays does not fluctuate, and there is no to-and-fro or oscillatory motion which tends to produce what may be called X-rays ghosts. It is well known that these ghosts are often puzzling to the surgeon.

In my experiments I was surprised at the small amount of current necessary with a voltage of forty thousand to produce a strong development of the X-rays. The use of ten milliamperes was dangerous to the tube; the anode grew white hot, and the Crookes' tube resembled an enclosed arc lamp. It was interesting also to notice that the usual fluorescence ceased to be noticeable; and although the tube was of a milky white hue, the X-rays were extraordinarily brilliant. In my first experiments the fall of resistance in the tube was so rapid that the anti-kathode was melted. In the case of all the tubes with which I have experimented, the fall in resistance advances very rapidly with the degree of reddening of the anti-kathode. When this becomes red, or when a red spot appears on it, the difference of potential between the terminals of the tube does not in general exceed twenty thousand volts.

It would seem therefore uneconomical to continue the use of a high potential machine when this critical point is reached. At this point, moreover, the rays seem to be given off most vigorously, and at this stage a quantity machine giving a comparatively small voltage could be substituted to advantage for a coil or other apparatus giving six to eight inch sparks. A large storage battery makes it possible to regulate the strength of the current which is at any moment exciting the tube. I accomplish this at present by means of a liquid resistance, which enables me to graduate the strength of the current to any extent. This advantage is a very great one, and is not possessed by any other method. It seems possible, by carefully regulating the strength

of the current and the voltage, to obtain photographs of the tendons, and possibly the muscles; for the photographs which I have already obtained show great contrasts, and there are indications of muscular layers and tendons. The contrast between the bones and the flesh is extraordinary, much greater than in the X-ray pictures usually obtained by the Rhumkorf coil.

The investigator, by means of the liquid resistance, can keep the tube at the same point of excitation. For the scientific study of the X-rays nothing seems better adapted than this large battery plant which I have had constructed, and it is not impossible that a smaller plant of the same number of cells, but with less capacity, may be desirable for large hospitals.

The first step in an investigation of the X-rays is to obtain a steady source of these rays: one of the essentials for the accomplishment of this is a steady current which can be regulated. This, I believe, I have secured. The next step will be the proper control of the amount of gas in the tube. At one time I believed that an oscillatory discharge was necessary for the strongest manifestation of the rays. My experiments, however, with a steady current have shown me that an oscillatory discharge is not essential; such a discharge could not take place through the large resistance which I used—4,000,000 ohms. Such are some of the results which can be obtained by the use of this large battery.

THE CRUISE AND DEEP-SEA EXPLORATION OF THE "SIBOGA" IN THE INDIAN ARCHIPELAGO.

THE annual summer meeting of the Netherlands Zoological Society, which was held in Amsterdam on July 1, was of more than usual interest on account of the fact that it was attended by all the members of the scientific staff of the *Siboga* expedition, who returned only a few weeks before from their one year's cruise in the different basins of the Indian Archipelago, during which they covered a distance of about 12,000 sea miles, *i.e.* about half the circumference of the globe. The track, as indicated on the accompanying Fig. 1, commenced at Soerabaja on March 7, 1899; it ended in the same port on February 27, 1900. The vessel, which is a cruiser belonging to the Dutch Royal Navy, was on its first trip, and before its departure was specially fitted up for the work of the cruise, both with a sounding apparatus of Le Blanc and of Lucas, with some 20 kilometres of wire rope for dredging purposes, and with all modern appliances for pelagic fishing, for plankton collection and for deep-sea work (a "sondeur à clef" of the Prince of Monaco, apparatus for obtaining sea-water from given depths according to Petterson and Sigsbee, Hensen's nets, &c.)

FIG. 1.—Track of the *Siboga*.

It may here be mentioned that very thorough experiments were made with Mr. G. H. Fowler's net, which is specially intended for plankton from given depths, and which can be opened and shut at will at any moment. About this net, which is of very recent invention, and which has as yet only been used by Mr. Fowler himself, and perhaps on board the *Valdivia*, the members of the *Siboga* expedition are very enthusiastic. It is most trustworthy in its results and fruitful in its catches.

The leader of the *Siboga* expedition, Prof. Max Weber of Amsterdam, well-known by his former expeditions to the East Indies, to the far north and to South Africa, was accompanied by Madame Weber-van Bosse, herself an accomplished naturalist, who made a very complete collection of Algæ during the cruise, and who settled three very important points as a result of the observations made, viz.: (1) the presence in unexpected quantities of calcareous Algæ (Lithothamnion) in the Archipelago, so that they build up reefs of considerable dimensions, in depths of 3 to 40 metres, in one case even at 120 metres. Different circumstances of level, current, &c., must co-operate to render the occurrence of Lithothamnion in such quantities possible: the expedition found them realised in at least thirty different localities, and henceforth the possible contribution of Lithothamnion-remains to the formation of the earth's crust will in many cases have to be reconsidered by the geologists. (2) The presence of a minute vegetal organism about which of late years English and German naturalists have considerably differed in opinion: the Coccosphære. Neither the members of the German Plankton nor those of the *Valdivia* expedition have succeeded in satisfying themselves that these miniature spheres with adherent discs of lime, already known in the Cretaceous period and everywhere present on the bottom of the sea, are organisms and not inorganic concretions or sediments. Mme. Weber has now succeeded in demonstrating the truth of the contrary, and has found this very lowly organised alga in great abundance, and entirely agrees with Mr. George Murray's statements concerning the alga-nature of the coccospheres; she has even found in this alga green chromatophores, and has seen phases of division of the spheres; (3) the presence of shell- and rock-perforating algæ, a group hitherto neglected in the tropics, of which she has brought home a great number.

The zoological collections of the *Siboga* are very extensive, both those collected on the coral-reefs and from the very different depths. Deep-sea animals were met with at depths of about 150 fathoms, where they would hardly have been expected, but where their presence is explained by certain hydrographical circumstances to be mentioned later. Porifera, and among them the most diverse Hexactinellids, were exceedingly numerous. East of the Aru Islands, gigantic

specimens of Adeona were captured. This curious Bryozoarian, of leaf-like shape and attached to a segmented stem, has sometimes been considered as one of the Isidinæ.

Of the curious solitary Alcyonarians, the Haimeidæ, which up to now are known as small specimens from the Red Sea and from Algiers, a species of a very considerable size has been met with. Amphianthus, an absolutely flat Actinian, was found on the shell of a Dentalium, and amongst the numerous Echinoderm-finds material abounds to definitely settle the question about the regeneration and the so-called comet forms of Linckia. It could be demonstrated that the regeneration takes place, without any part of the disc being preserved, from a bare arm-fragment. On these Linckias the parasitical molluscs, Thyca and Stylifer, were often present. Various Solenogastres were captured, and many interesting Cephalopods. The fish collection is also very considerable, and a great many deep-sea forms are among them, of which a specimen of Ruvettus attains to a size of several feet.

The most beautifully transparent larval Muræenas were at the other end of the scale, and were also exhibited at the meeting. Both they and other pelagic organisms, Medusæ, Heteropods, &c., were most successfully preserved in formalin. On the whole the preservation of all the specimens, for which the most various methods were employed, is first-rate; and Mr. Nierstrasz, to whose supervision this had been more especially entrusted, received due recognition of his merits on this head. Some hundred bottles of plankton have yet to be sorted and worked out. Dr. Versluys communicated to the meeting the results of investigations into the amount of oxygen contained in the sea-water at different points which he had made during the cruise, and Prof. Weber called attention to certain hydrographical results of primary importance obtained by the expedition.

The gist of these is that the communication between the deep water of the Indian and Pacific Oceans and that of the Archipelagan basins is very different from what it was expected to be. The different straits between the lesser Sunda Islands, Bali to Flores, are none of them deep enough to allow of any horizontal passage of the deeper and colder strata (where the temperature is 0·9° C.) into the Banda basin and its continuations between Flores and Timor and between Flores and Celebes. These undoubtedly receive their cold bottom-water from the Pacific Ocean by way of the deep communications indicated on the map to the north of Buru (the so-called Ceram sea), which opens out into the Pacific by a narrow passage (the so-called Moluccan passage). In the deep spurs, to which the name of Bali and Flores sea may be given, the expedition could actually demonstrate the existence of a bottom-current which flows westward and which brings the cold water from the Banda sea into these recesses where the supply from the Indian Ocean through the numerous straits is only superficial and restricted to surface-water of a temperature of more than 12° C. The cold bottom-current of 3° C. just alluded to, which slowly flows westward out of the Banda sea, even rises up along the sloping coasts of the Kangeang-Paternoster-Postillon islands (not indicated on the map) situated north of this deep sea spur, as could be demonstrated both by serial temperatures and even by the net, which, as mentioned above, brought up deep-sea forms from comparatively shallow water, just because of this bottom current, which, being hemmed in, flows towards the surface.

The temperature of 3° C. referred to above is the uniform minimum temperature for the whole of the Banda basin below the depth of 1600 m., and the theoretical conclusion that no deeper communications than this exist with either of the Oceans was practically verified, and also (as indicated above) that the cold water of the greater depths comes from the Pacific and not from the Indian Ocean.

The Banda Sea, *sensu strictiori*, was further found to be different from what was hitherto held. On charts, mention is made of a depth of 7000 metres (4000 fathoms) in the neighbourhood of Banda. This depth has been demonstrated by the *Siboga* to be due to some error, the depth being nowhere below 5500 metres, and the basin itself being most unexpectedly intersected by two shallow ridges, clearly visible on the map, the more westward of which has been named the Siboga Ridge. Geological speculations concerning this part of the earth's crust will undoubtedly be influenced by these results.

For the distribution of deep-sea animals, the difference of a couple of degrees between the bottom-water of these basins and that of the oceans will certainly not have much importance; and even the ridges will in the long run prevent only very few deep-sea animals from penetrating into the basins in the course of generations, when the difference of pressure can be slowly neutralised. At all events, the catches did not justify expectations that these enclosed deep basins might harbour a deep-sea fauna which, by its isolation from the ocean, had developed into peculiar local deep-sea faunas particular to those basins.

The hydrographical work of the expedition has thus been of very considerable importance, and will soon be also noticeable in improved navigating charts for the regions explored. Even geographical corrections of considerable amount are amongst the results of the cruise. The south coast of the large island of Timor (of which the eastern half is a Portuguese, the western a Dutch possession) will have to undergo a radical alteration, as indicated on the accompanying sketch (Fig. 2). Thus the *Siboga* expedition has not inconsiderably reduced the colonial surface area of Portugal, having anchored in spots which, according to the present maps, lie far inland.

The expedition can thus be complimented on having achieved a most successful piece of work, and it is undoubtedly in the first place due to the undaunted energy of the leader, Prof. Weber, and to the exemplary skill of the officer in command of the vessel, Comm. Tydeman, who for many years has already been one of the leading hydrographers in the Archipelago. The liberality of the Naval Department, and its active co-operation in all that pertained to the expedition, have been especially noticeable.

The results, both hydrographical, botanical, zoological and geological, will, as soon as possible, be worked out by different

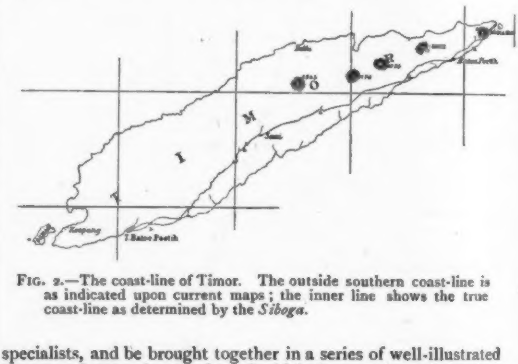

FIG. 2.—The coast-line of Timor. The outside southern coast-line is as indicated upon current maps; the inner line shows the true coast-line as determined by the *Siboga*.

specialists, and be brought together in a series of well-illustrated quarto volumes, the number of which is roughly estimated at about fifteen. Several specialists, both Dutch and foreign, have already promised to co-operate, and what with Alcock's researches in the Bay of Bengal, the *Valdivia's* exploration of the Indian Ocean, the Australian investigations of the Barrier Reef and the Torres Straits, the Belgian Antarctic expedition, and Agassiz's dredging expeditions in the Pacific, we can safely say that, by the time this publication will have appeared, we will have obtained a very thorough knowledge of an important portion of the abyssal regions, towards the exploration of which the *Lightning*, *Porcupine* and *Challenger* have set the example, and the *Blake*, *Albatross*, *Travailleur*, *Talisman*, *Gazelle*, *Vettor Pisani*, *Willem Barents*, *Hirondelle* and *Princesse Alice* have so considerably contributed from other parts of the globe.

A. A. W. H.

EXPERIMENTATION ON EMOTION.

OF points where physiology and psychology touch, the place of one lies at the phenomenon "emotion." Built upon sense-feeling much as cognition is built upon sense-perception, emotion may be regarded almost *as* a "feeling"—a "feeling" excited, not by a simple unelaborated sensation, but by a group or train of ideas. To such compound ideas it holds relation much as does "feeling" to certain species of simple sense-perceptions. It has a special physiological interest in that certain visceral reactions are peculiarly concomitant with it. Heart, blood-vessels, respiratory muscles and secretory glands

play special and characteristic *rôles* in the various emotions. These viscera, though otherwise remote from the general play of psychical process, are affected vividly by the emotional. Hence many a picturesque metaphor of proverb and phrase and name—"the heart is better than the head," anger "swells within the breast," "Richard Cœur de Lion." It was Descartes who first relegated the emotions to the brain. Even this century Bichat wrote, "The brain is the seat of cognition, and is never affected by the emotions, whose sole seat lies in the viscera." But brain is now admittedly a factor necessary in all higher animal forms to every mechanism whose working has consciousness adjunct.

What is the meaning of the intimate linkage of visceral actions to psychical states emotional? To the ordinary day's consciousness of the healthy individual the life of the viscera contributes little at all, except under emotion. The perceptions of the normal consciousness are rather those of outlook upon the circumambent universe than inlook into the microcosm of the "material me." Yet heightened beating of the heart, blanching or flushing of the blood-vessels, the pallor of fear, the blush of shame, the Rabelaisian effect of fright upon the bowel, the action of the lacrymal gland in grief, all these are prominent characters in the pantomime of natural emotion. Visceral disturbance is evidently a part of the corporeal expression of emotion. The explanation is a particular case in that of movements of expression in general. The hypothesis of Evolution afforded a new vantage point for study of that question. Fixed bodily expressions of emotion are hereditary. They are, especially in the "coarser or animal emotions," largely common to man and higher animals. The point of view is exemplified by Darwin's argument concerning the contraction of the muscles round the eyes during screaming. "Children when wanting food or suffering in any way cry out loudly like the young of most animals, partly as a call to their parents for aid, and partly from any great exertion serving as relief. Prolonged screaming inevitably leads to the engorging of the blood-vessels of the eye; and this will have led at first consciously and at last habitually to the contraction of the muscles round the eyes in order to protect them." Mr. Spencer writes: "Fear, when strong, expresses itself in cries, in efforts to hide or escape, in palpitations and tremblings; and these are just the manifestations which would accompany an actual experience of the evil feared. The destructive passions are shown in a general tension of the muscular system, in gnashing of the teeth and protrusion of the claws, in dilated eyes and nostrils, in growls: and these are weaker forms of the actions that accompany the killing of prey." In a word, expression of emotion is instinctive action.

Movement of expression, be it facial or vocal, let it involve the skeletal or the visceral musculature, must have an explanation the same in kind as that of other instinctive movement. To enter upon its "why" is to enter upon the "why" of instinct. Suffice it to say here that if we follow the doctrine of evolution we cannot admit any absolute break between man and brute even in the matter of mental endowment. The instinctive bodily expressions of emotion probably arose as attitudes useful in the animal's environment for defence, escape, seizure, embrace, &c. These as survivals have become symbolic for states of mind. Hence the intelligible nexus between the muscular attitude, the pose of feature, &c., and the emotional state of mind. But between action of the viscera and the psychical state the nexus is less obviously explicable. This latter connection adds a difficult corollary to the general problem.

The fact of the connection is on all hands admitted, but as to the manner of it opinion is at issue. Does (1) the psychical part of the emotion arise and its correlate nervous action then excite the viscera? Or (2) does the same stimulus which excites the mind excite concurrently and *per se* the nervous centres ruling the viscera? Or (3) does the stimulus which is the exciting cause of the emotion act first on the nervous centres ruling the viscera, and their action then generate visceral sensations; and do these latter, laden with affective quality as we know they will be, induce the emotion of the mind? On the first of the three hypotheses the visceral reaction will be secondary to the psychical, on the second the two will be collateral and concurrent, on the third the psychical process will be secondary to the visceral.

To examine the last supposition first. It is a view which in recent years has won notable adherents. Prof. William James writes: "Our natural way of thinking about these coarser emotions (*e.g.* "grief, fear, rage, love") is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My theory, on the contrary, is that *the bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur* IS *the emotion.*" "*Every one of the bodily changes, whatsoever it be, is* FELT, *acutely or obscurely, the moment it occurs.* If the reader has never paid attention to this matter, he will be both interested and astonished to learn how many different local bodily feelings he can detect in himself as characteristic of his various emotional moods." "If we fancy some strong emotion and then try to abstract from our consciousness of it all the feelings of its bodily symptoms we find we have nothing left behind, no "mind-stuff" out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains." "If I were to become corporeally anæsthetic, I should be excluded from the life of the affections, harsh and tender alike, and drag out an existence of merely cognitive or intellectual form."

Prof. Lange traces the whole psycho-physiology of emotion to certain excitations of the vasomotor centre. For him, as for Prof. James, the emotion is the outcome and not the cause or the concomitant of the organic reaction; but for him the foundation and corner-stone of the organic reaction is as to physiological quality vascular, namely, vasomotor. Emotion is an outcome of vasomotor reaction to stimuli of a particular kind. This stimulus induces a vasomotor action in viscera, skin, and brain. The change thus induced in the circulatory condition of these organs induces changes in the actions of the organs themselves, and these latter changes evoke sensations which constitute the essential part of emotion. It is by excitation of the vasomotor centre, therefore, that the exciting cause, whatever it chance to be, of emotion produces the organic phenomena which as felt constitute for Lange the whole essence of emotion. The teaching of Prof. Sergi closely approximates to that of Lange.

The views of James, Lange, and Sergi have common to them this, that the psychical process of emotion is secondary to a discharge of nervous impulses into the vascular and visceral organs of the body suddenly excited by certain peculiar stimuli, and that it depends upon the reaction of those organs. Prof. James's position in the matter is, however, not wholly like that of Prof. Lange. In the first place, he does not consider vasomotor reaction to be primary to all the other organic and visceral disturbances that carry in their train the psychological appanage of emotion; and Prof. Sergi, though more nearly in harmony with Lange, agrees with James in this. In the second place, Prof. James seems to distinctly include other "motor" sensations and centripetal impulses from musculature other than visceral and vascular, among those which causally contribute to emotion. Thirdly, he urges his theory as one completely competent only for the "coarser" emotions, among which he instances "fear, anger, love, grief." For Lange and Sergi the basis of apparition of all feeling and emotion is physiological, visceral, and organic, and has seat for the former authority exclusively, and for the latter eminently, in the vasomotor system.

To obtain some test of this view is not difficult by experiment. Appropriate spinal and vagal transection removes completely and immediately the sensation of all the viscera and of all the skin and muscles below the shoulder (see Fig. 1 on p. 330). The procedure at the same time cuts from connection with the organs of consciousness the whole of the circulatory apparatus of the body. I have had under observation dogs in which this had been carried out. I will cite an animal selected because of markedly emotional temperament. Affectionate toward the laboratory attendants, one of whom had her in charge, toward some persons and toward several inmates of the animal house she frequently showed violent anger. Her ebullitions of rage were sudden. Their expression accorded with a description furnished by Darwin. Besides the utterance of the growl, "the ears are pressed closely backwards, and the upper lip is retracted out of the way of the teeth, especially of the canines." The mouth was slightly opened and lifted; the eyelids widely parted; the pupils dilated. The hair along the mid-dorsum, from close behind the head to a point more than half way down the trunk, became rough and bristling.

The reduction of the field of sensation in this animal by the

procedure above-mentioned produced no obvious diminution or change of her emotional character. Her anger, her joy, her disgust, and when provocation arose her fear remained as evident as ever. Her joy at the approach or notice of the attendant, her rage at the intrusion of a cat with which she was unfriendly, remained as active and thorough. But among the signs expressive of rage the bristling of the coat along the back no longer occurred. On he other hand, the eyes were well opened, and the pupil distinctly dilated in the paroxysm of anger. Since the brain had been by the transection shut out from discharging impulses *via* the cervical sympathetic the dilatation of pupil must have occurred by inhibition of the action of the oculomotor centre.

The coming of a visitor whose advent months before had elicited violent anger, again provoked an exhibition of wrath significant as ever. The expression was that of aggressive rage. The animal followed each movement of the stranger as though of an opponent, growling viciously. A cat with which she was never friendly, and a monkey new to the laboratory, approaching too near the kennel, excited similar ebullitions. No doubt was left in our minds that sudden attacks of violent anger were still easily excited. But she also gave evidence daily that she had the accession of joyous pleasure and delight she had always shown at the approach of the attendant the first thing of a morning, or at feeding time, or when caressed by him, or encouraged by his voice.

Few dogs even when very hungry can be prevailed on to touch dog's-flesh as food. Almost all turn from it with signs of repugnance and dislike. I had strictly refrained from testing

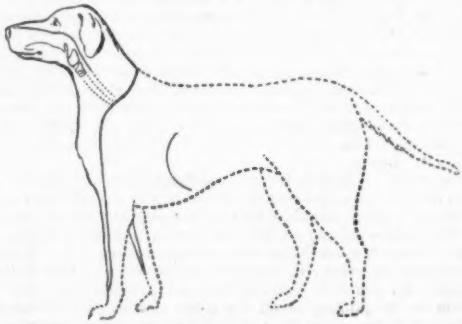

FIG. 1.—Diagram showing the great reduction of the field of sentivity. The head and neck and the diaphragm muscle (indicated by the curved line behind the chest) are practically the only parts left sensitive. The remainder of the body and the limbs, as well as the digestive and respiratory organs behind the throat, and the whole of the circulatory and other organs, are entirely cut off from making any contribution to consciousness.

this animal previously with regard to disgust at dog's-flesh offered in her food. Flesh was given her daily in a bowl of milk, and this she took with relish. The meat was cut into pieces rather larger than the lumps of sugar usual for the breakfast table. It was generally horse-flesh, sometimes ox-flesh. We proceeded to the observation thus: the bowl was placed by the attendant in the corner of the stall, with milk and meat in every way as usual; but the meat was flesh from a dog killed on the previous day. Our animal eagerly drew itself toward the food; it had seen the other dogs fed, and evidently itself was hungry. Its muzzle had almost dipped into the milk before it suddenly seemed to find something there amiss. It hesitated, moved its muzzle about above the milk, made a venture to take a piece of the meat, but before actually seizing it stopped short and withdrew again from it. Finally, after some further examination of the contents of the bowl (it usually commenced by taking out and eating the pieces of meat), without touching them, the creature turned away from the bowl and withdrew itself to the opposite side of the cage. Some minutes later, in result of encouragement from us to try the food again, it returned to the bowl. The same hesitant display of conflicting desire and disgust was once more gone through. The bowl was then removed by the attendant, emptied, washed, and horse-flesh similarly prepared and placed in a fresh quantity of milk was offered in it to the animal. The animal once more drew itself toward the bowl, and this time began to eat the meat, soon emptying the dish. To press the flesh upon our animal was of no real avail on any occasion; the coaxing only succeeded in getting her to, as it were, re-examine but not to touch the morsels. The impression made on all of us by the dog's behaviour was that something in the dog's-flesh was repulsive to her, and excited disgust unconquerable by ordinary hunger. Some odour attaching to the flesh seemed the source of its recognition.

Fear appeared clearly elicitable. The attendant, approaching from another room of which the door was open, chid the dog in high scolding tones. The creature's head sank, her gaze turned away from her advancing master, and her face seemed to betray dejection and anxiety. The respiration became unquiet, but the pulse never changed its rate.

In the face of these observations the vasomotor theory of the production of emotion becomes, I think, untenable: also that visceral sensations or presentations are *necessary* to emotion. A mere remnant of all the non-projecting or affective senses was left, and yet emotion persisted. If I understand it aright, Prof. James and Lange's theory lays stress on organic and visceral presentations, but re-presentations of the same species might no doubt be put forward in their place. That would be a somewhat different matter. To exclude the latter hypothesis, the deprivation of vascular and organic sensation might have to date from a very early period of the individual life. Experience early acquires its emotional data. If after that all fresh presentation were precluded, re-presentation might still be possible on the basis of already gained experience. But it is noteworthy that one of the dogs under observation had been deprived of its sensation when only nine weeks old. Disgust for dog's flesh could hardly have genesis in the experience of nine weeks of puppy life in the kennel of the laboratory.

Organic and vascular reaction, though not the actual excitant of emotion, does nevertheless much strengthen it. That is part of the kernel of the old contention about the strength of emotion in the art of the artist. Hamlet's description of the actor, as really moved by his expression, may be accepted as an answer.

But, returning to the main question, we are forced back toward the likelihood that the visceral expression of emotion is *secondary* to the psychical state, or rather to the cerebral nervous action correlate with that. There is plenty of evidence of the strong nexus between emotion and muscular action. As we commonly phrase it, "emotion moves us," hence the word itself. Emotion if developed in intensity, impels toward vigorous movement. Every vigorous movement of the body, though its more obvious instrument be the skeletal musculature of the limbs and trunk, involves also the less noticeable co-operation of the viscera, especially of the circulatory and respiratory. The demand made upon the muscles that move the frame for further expenditure of power involves a heightened action of the nutrient organs which supply to the muscles their material for energy. This increased action of the viscera is therefore colligate with this activity of muscles. We should therefore expect visceral action to occur along with the muscular expression of emotion. The close tie between visceral action and states of emotion need not therefore surprise us.

That emotion is primarily a cerebral process obtains support from observations where the hemispheres of the brain have been removed. Prof. Goltz observed a dog kept many months in that condition. It on no occasion gave any evidence of joy or pleasure in commerce either with man or beast. Anger or displeasure, Goltz says, it repeatedly expressed, both by gesture and by voice. Of sexual emotion it never gave a sign. Save for expression of displeasure when too roughly handled, it was indifferent and supremely neutral to its surroundings. We are, of course, in observations whose basis is such experiment as this, hopelessly cut off from introspective help. It can be urged that the expression of emotion might be provocable, and nevertheless the psychical emotion remain absent. On such an hypothesis the same stimulus which excites the mind must excite concurrently and *per se* excite motor centres producing movement appropriate to an affective process in the mind. This is not improbable. All sensations referred to the body itself rather than interpreted as qualities of objects in the external world, tend to be tinged with "feeling." Sense organs which initiate sensations tinged with feeling tend to excite motor centres directly and imperatively. Hence, in animals reduced to merely spinal condition, stimuli calculated to produce pain normally (of course, unable to do so in a spinal animal

incapable of consciousness), evoke movements appropriate for escape from or removal of the stimulus applied. Now "feeling" is implicit in the emotional state; the state is an "affective state." In the evolution of emotion the revival of "feelings" pleasurable and painful must have played a large part. Hence the close relation of emotion with sense organs that can initiate bodily pain or pleasure, and hence its connection with impulsive or instinctive movement. There is no wide interval between the reflex movement of the spinal dog, whose foot attempts to scratch away an irritant applied to its back—both leg and back absolutely detached from consciousness—and the reaction of the decerebrate dog that turns and growls and bites at the fingers holding his hind foot too roughly. In the ormer case the motor reaction occurs, although the mind is not even aware of the stimulus, far less percipient of it as an irritant. The action occurs, and plays the pantomime of feeling; but no feeling comes to pass. In the latter case the motor reaction occurs, and is expressive of emotion; but it is probably the reaction of an organic machine, which can be started working, though the mutilation precludes the psychosis of emotion.

And with the gesture and the attitude will occur the visceral concomitant. It would be consonant with what we know of reflex action if the spur that started the muscular expression should simultaneously and of itself initiate, also, the visceral adjunct reaction. It is almost impossible to believe that with the mere stump of brain that remained to Goltz's dog there could be any elaboration of a percept. All trace of memory was lacking to the creature. Yet though not evincing other emotion, anger it showed as far as expression can yield revelation. Fear, joy, affection seem, therefore, in the observation of this skilled observer of animal mind, to demand higher nervous organisation than does anger. Be that as it may, the retention of its expression by Goltz's dog indicates that by "retrogradation" the complex movement of expression has in certain emotions passed into a simple reflex act. When the habituating practice of acts is carried far the determining motives finally become, even in impulsive acts, weaker and more transient. The external stimulus originally aroused a strongly affective group of ideas, which operated as a motive, but now it causes a discharge of the act before it can be apprehended as an idea. The impulsive movement of a "lower," "coarser," so-called "animal" emotion, has in this case become an automatic reflex process no longer necessarily combined with the psychical state whence it arose, of which it is normally at once the adjunct and the symbol.

C. S. SHERRINGTON.

THE CENTENARY OF THE ROYAL COLLEGE OF SURGEONS.

MR. VICTOR PLARR'S article, in last week's NATURE, on the celebration of the centenary of the Royal College of Surgeons of England contained a brief statement of the ceremonies which were to commence on the day we went to press. The proceedings were opened on Wednesday morning, July 25, when demonstrations were given in the Hunterian Museum of the College by the conservator, Prof. C. Stewart, F.R.S., who conducted visitors round the galleries, pointing out and describing some of the more important and interesting specimens. At the same time, in the theatre of the Examination Hall, Dr. T. G. Brodie, director of the laboratories of the Conjoint Board, gave an account of some of the work recently carried out in the research laboratories. In the evening a conversazione was held at the College, and was attended by many distinguished guests. Demonstrations were again given by Prof. Stewart and Dr. Brodie on Thursday morning; and in the afternoon, Sir William MacCormack, the president, delivered an address of welcome, and presented the diploma of Honorary Fellow to the Marquis of Salisbury and the Earl of Rosebery. As already stated (p. 294), the Prince of Wales received the diploma on July 24; and the form of the Royal diploma is the same as that employed for all the Honorary Fellowships.

The following is the list of other Honorary Fellows to whom diplomas were presented on Thursday:—E. Albert, professor of clinical surgery, University of Vienna; C. B. Ball, Regius professor of surgery, University of Dublin; E. Bassini, professor of clinical surgery, Royal University of Padua; E. H. Bennett, professor of surgery, Trinity College, Dublin; J. W. Berg, professor of surgery, Royal Caroline Institute of Medicine and Surgery, Stockholm; Prof. von Bergmann, Berlin; O. Bloch, professor of surgery, University of Copenhagen; E. Bottini, professor of clinical surgery, Royal University of Pavia; I. H. Cameron, professor of clinical surgery, University of Toronto; Dr. Salvador Cardenal Fernandez, vice-president, Royal Academy of Medicine and Surgery, Barcelona; Antonino D'Antona, professor of surgery, Royal University of Naples; Francesco Durante, professor of clinical surgery, Royal University of Rome; Prof. Dr. Friedrich von Esmarch, Kiel; W. S. Halsted, professor of surgery, Johns Hopkins University, Baltimore; Hon. Sir W. H. Hingston, professor of clinical surgery, University of Laval; Surgeon-General James Jameson, C.B., Director-General, Army Medical Service; W. W. Keen, professor of the principles of surgery and of clinical surgery, Jefferson Medical College, Philadelphia; Theodor Kocher, professor of surgery, University of Bern; Prof. Dr. Franz König, Berlin; Prof. Kosinskij, professor of surgery in the University of Warsaw; Prof. Dr. E. G. F. Küster, Marburg; Elie Lambotte, Brussels; Odilon Marc Lannelongue, professor of surgical pathology, Faculty of Medicine of Paris; Karl Gustaf Lennander, professor of surgery and obstetrics, University of Upsala; W. Macewen, F.R.S., Regius professor of surgery, University of Glasgow; Colonel Kenneth MacLeod, professor of clinical and military medicine, Army Medical School, Netley; Julius Nicolaysen, professor of surgery, Royal University of Christiania; Sir Henry Frederick Norbury, K.C.B., Director-General, Medical Department of the Royal Navy; Leopold Ollier, professor of clinical surgery, University of Lyons; Victor Pachoutine, president, Imperial Military Academy of Medicine, St. Petersburg; Samuel Pozzi, professor in the Faculty of Medicine of Paris; Colonel D. C. O'Connell Raye, Indian Medical Service; T. G. Roddick, professor of surgery, McGill University, Montreal; Federico Rubio y Gali, member of the Royal Academy of Medicine of Madrid; Nicolas Wassilievitch Sklifossovsky, director and Emeritus professor, Imperial Clinical Institute of the Grand Duchess Helena Pavlovna, St. Petersburg; Paul Tillaux, professor of clinical surgery, Faculty of Medicine of Paris; Nicolas Veliaminoff, professor of surgery, Imperial Military Academy of Medicine, St. Petersburg; John Collins Warren, professor of surgery, Harvard University; Robert Fulton Weir, professor of clinical surgery, Columbia University, New York. After the presentation brief addresses of thanks were delivered by Prof. v. Bergmann of Berlin, Prof. Durante of Rome, Dr. W. W. Keen of Philadelphia, Prof. Lannelongue, and Dr. T. G. Roddick of Montreal.

FACTS OF INHERITANCE.[1]

ONE of the distinctive features of the nineteenth century has been a reduction in the number of supposed separate powers or entities—the use of William of Occam's razor, in fact. In view of this progress towards greater precision of phraseology, it cannot be a matter for surprise that a biologist should affirm that to speak of the "Principle of Heredity" in organisms is like speaking of the "Principle of Horologity" in clocks. For heredity is certainly no power or force, or principle, but a convenient term for the relation of organic or genetic continuity which binds generation to generation.

Another distinctive feature in scientific progress has been the introduction of precise measurement. In the development of natural knowledge, science begins where measurement begins. This is the case in regard to inheritance. While nothing can take the place of experiment, much has been gained by the application of statistical and mathematical methods to biological results—a new contact between different disciplines—which we may particularly associate with the names of Mr. Francis Galton and Mr. Karl Pearson.

I. THE PHYSICAL BASIS OF INHERITANCE.

What was for so long quite hidden from inquiring minds, or but dimly discerned by a few, is now one of the most marvellous of biological commonplaces—that the individual life of the great majority of plants and animals begins in the union of two minute elements—the sperm-cell and the egg-cell. If inheritance includes all that the living creature is or has to start with in virtue of its genetic relation to its parents and ancestors, then it is

[1] Abridged from a discourse delivered at the Royal Institution on Friday March 30, by Prof. J. Arthur Thomson, F.R.S.

plain that the physical basis of inheritance is in the fertilised ovum. As regards property, there is an obvious distinction between the inheritance and the person who inherits, but there is no such distinction in biology. The fertilised egg-cell *is* the inheritance, and is at the same time the potential inheritor.

An organic inheritance means so much, even when we use the magic word potentiality, that we may consider for a moment the difficulty which rises in the minds of many when they remember that the egg-cell is often microscopic, and the sperm-cell often only 1/100,000th of the ovum's size. Can there be room, so to speak, in these minute elements for the complexity of organisation supposed to be requisite? The difficulty will be increased if the current opinion be accepted that only the nuclei within the germ-cells are the true bearers of the hereditary qualities.

In reference to this difficulty, it may be recalled that the students of physics tell us that the image of a *Great Eastern* filled with framework as intricate as that of the daintiest watches does not exaggerate the possibilities of molecular complexity in a spermatozoon, whose actual size may be less than the smallest dot on the watch's face. Secondly, as we learn from embryology that one step conditions the next and that one structure grows out of another, we are not forced to stock the microscopic germ-cells with more than initiatives. Thirdly, we must remember that the development implies an interaction between the growing organism and a complex environment without which the inheritance would remain unexpressed, and that the full-grown organism includes much that was not inherited at all, but has been acquired as the result of nurture or external influence.

The central problem of heredity is to form some conception of what we have called the relation of genetic continuity between successive generations; the central problem of inheritance is to measure the resemblances and differences in the hereditary characters of successive generations, and to arrive, if possible, at some formula which will sum up the facts. Therefore, while it is interesting to ask how an organisation supposed to be very complex may be imagined to find physical basis in a microscopic germ-cell, the same sort of question may be raised in regard to a ganglion-cell. It is not distinctively a problem of heredity. Similarly, while it is interesting to inquire into the orderly and correlated succession of events by which the fertilised egg-cell gives rise to an embryo, this is the unsolved problem of physiological embryology.

In the preformationist theories, which asserted the pre-existence of the organism and all its parts, in miniature, within the germ—there was a kernel of truth well concealed within a thick husk of error. For we may still say that the future organism is implicit in the germ, and that the germ contains not only the rudiment of the adult organism, but the potentiality of successive generations as well. But what baffled the earlier investigators was the question how the germ-cell comes to have this ready-made organisation, this marvellous potentiality.

An attempt to solve this difficulty of accounting for the complex organisation presumed to exist in the germ-cell is expressed in a theory which occurred at intervals in the long period between Democritus and Darwin, the theory of pangenesis. On this theory, the cells of the body are supposed to give off characteristic and representative gemmules; these are supposed to find their way to the reproductive elements, which thus come to contain concentrated samples of the different components of the body, and are, therefore, able to develop into an offspring like the parent. The theory involves many hypotheses, and is avowedly unverifiable in direct sense-experience, but it is more to the point to notice that there is another theory of heredity which is, on the whole, simpler, which seems, on the whole, to fit the facts better, especially the fact that our experience does not warrant the conclusion that the modifications or acquired characters of the body of the parent affect in any specific and representative way the inheritance of the offspring.

As is well known, the view which most biologists now take of the uniqueness of the germ-cells is expressed in the phrase "germinal continuity." There is a sense, as Mr. Galton says, in which the child is as old as the parent, for when the parent's body is developing from the fertilised ovum, a residue of unaltered germinal material is kept apart to form the future reproductive cells, one of which may become the starting-point of a child. In many cases, from worms to fishes, the beginning of the lineage of germ-cells is demonstrable in very early stages before the differentiation of the body-cells has more than begun. In the development of the threadworm of the horse, according to Boveri, the very first cleavage divides the fertilised ovum into two cells, one of which is the ancestor of all the body-cells, and the other the ancestor of all the germ-cells. In other cases, particularly among plants, the segregation of germ-cells is not demonstrable until a relatively late stage. Weismann, generalising from cases where it seems to be visibly demonstrable, maintains that in all cases the germinal material which starts an offspring owes its virtue to being materially continuous with the germinal material from which the parent or parents arose. But it is not on a continuous lineage of recognisable germ-*cells* that Weismann insists, for this is often unrecognisable, but on the continuity of the germ-*plasm*—that is, of a specific substance of definite chemical and molecular structure which is the bearer of the hereditary qualities. In development, a part of the germ-plasm, "contained in the parent egg-cell is not used up in the construction of the body of the offspring, but is reserved unchanged for the formation of the germ-cells of the following generation." Thus the parent is rather the trustee of the germ-plasm than the producer of the child. In a new sense, the child is a chip of the old block. The conception of a germ-plasm is hypothetical, just as the conception of a specific living stuff or protoplasm is hypothetical. In the complex microcosm of the cell, we cannot point to any one stuff and say, "this is protoplasm"; it may well be that vital activity depends upon several complex stuffs which, like the members of a carefully constituted firm, are characteristically powerful only in their inter-relations. In the same way, we cannot demonstrate the germ-plasm, even if we may assume that it has its physical basis in the stainable nuclear bodies or chromosomes. The theory has to be judged, like all conceptual formulæ, by its adequacy in fitting facts.

II. DUAL NATURE OF INHERITANCE.

Apart from exceptional cases, the inheritance of a multicellular animal or plant is dual, part of it comes from the mother and part of it from the father.

Prof. E. B. Wilson states the general opinion of experts somewhat as follows:—As the ovum is much the larger, it is believed to furnish the initial capital—including it may be a legacy of food-yolk—for the early development of the embryo. From both parents alike comes the inherited organisation which has its seat (according to many) in the readily stainable (chromatin) rods of the nuclei. From the father comes a little body (the centrosome) which organises the machinery of division by which the egg splits up, and distributes the dual inheritance equally between the daughter-cells.

Recent researches confirm a prophecy which Huxley made in 1878: "It is conceivable, and indeed probable, that every part of the adult contains molecules derived both from the male and from the female parent; and that, regarded as a mass of molecules, the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male." "What has since been gained," Prof. Wilson says, "is the knowledge that this web is to be sought in the chromatic substance of the nuclei, and that the centrosome is the weaver at the loom."

In regard to these conclusions, three notes are necessary. (*a*) Although inheritance is dual, it is in quite as real a sense multiple, from ancestors through parents. (*b*) If Loeb is able to induce artificial parthenogenesis in sea-urchins' eggs exposed for a couple of hours to sea-water to which some magnesium chloride has been added; if Delage is able to fertilise and to rear normal larvæ from non-nucleated ovum-fragments of sea-urchin, worm and mollusc, we should be chary of committing ourselves definitely to the conclusion that the nuclei are the exclusive bearers of the hereditary qualities, or that both must be present in all cases. Furthermore, the fact that an ovum without any sperm-nucleus, or an ovum-fragment without any but a sperm-nucleus, can develop into a normal larva points to the conclusion, probable also on other grounds, that each germ-cell, whether ovum or spermatozoon, bears a complete equipment of hereditary qualities. (*c*) It must be carefully observed that our second fact does not imply that the dual nature of inheritance must be patent in the full-grown offspring, for hereditary resemblance is often strangely unilateral, the characters of one parent being "prepotent," as we say, over those of another.

III. DIFFERENT DEGREES OF HEREDITARY RESEMBLANCE.

One step of progress during the Darwinian era has been the recognition of inheritance as a fact of life which requires no further proof.

Yet this aspect of the study of heredity is by no means worked

out. Thus there are some characters, *e.g.* tendency to certain diseased conditions, which are more frequently transmitted than others, and we ought to have, in each case, precise statistics as to the probabilities of transmission.

Again, there are some subtle qualities whose heritability must not be assumed without evidence. Thus it is of very great importance to students of organic evolution that Prof. Karl Pearson has recently supplied, for certain cases, definite proof of the inheritance of fecundity, fertility and longevity.

The familiar saying, "like begets like," should rather read, "like tends to beget like," since variation is quite as important a fact as complete hereditary resemblance. If it seems that in many cases the offspring is practically a facsimile reproduction of the parent, this may be due to absence of variation, or, what comes almost to the same thing, to great completeness of inheritance; but it is more likely to be due to our ignorance, to our inability to detect the idiosyncrasies.

But it will be granted that the completeness with which the characters of race, genus, species and stock are reproduced generation after generation is one of the large facts of inheritance. But this does not sum up our experience, and we must face the task of considering the different degrees of hereditary resemblance. For these a confused classification and a troublesome terminology has been suggested, but it will be enough to restrict attention to three familiar cases—blended, exclusive and particulate inheritance.

A preliminary consideration must be attended to. It is a matter of observation that there are great differences in the degree in which offspring resemble their parents; but it is surely a matter of conjecture that lack of resemblance is necessarily due to incompleteness in the inheritance. Indeed, the fact that the resemblance so often reappears in the third generation makes it probable that the incompleteness is not in the inheritance, but simply in its expression. The characters which seem to be absent, to "skip a generation," as we say, are probably part of the inheritance, as usual. But they remain latent, neutralised, silenced (we can only use metaphors) by other characters, or else unexpressed because of the absence of the appropriate stimulus.

(*a*) In *blended* inheritance, the characters of the two parents, *e.g.* in regard to a particular structure, such as the colour of the hair, may be intimately combined in the offspring. This is particularly well seen in some hybrids, where the offspring often seems like the mean of the two parents; it is probably the most frequent mode of inheritance.

(*b*) In *exclusive* inheritance, the expression of maternal or of paternal characters in relation to a given structure, such as eye-colour, is suppressed. Sometimes the unilateral resemblance is very pronounced, and we say that the boy is "the very image of his father," or the daughter "her mother over again"; though even more frequently the resemblance seems "crossed," the son taking after the mother, and the daughter after the father.

(*c*) It is convenient to have a third category for cases where there is neither blending nor exclusiveness, but where in the expression of a given character, part is wholly paternal and part wholly maternal. This is called *particulate* inheritance. Thus, an English sheep-dog may have a paternal eye on one side, and a maternal eye on the other. Suppose the parents of a foal to be markedly light and dark in colour; if the foal is light brown the inheritance in that respect is blended, if light or dark it is exclusive, if piebald it is particulate. In the last case there is in the same character an exclusive inheritance from both parents.

The facts above referred to may be considered in another aspect, in terms of what is called the quality of prepotency. In the development of a character the paternal or the maternal qualities may predominate, as in unequal blending where there is relative prepotency, or in exclusive inheritance where the prepotency in respect to a given character is absolute. It seems doubtful whether we gain much by using the word, since all these general terms are apt to form the dust particles of intellectual fog; but we have to do with the fact that in respect to certain characters the paternal inheritance seems more potent than the maternal, or *vice versa*.

It seems that one of the ways in which the quality of prepotency may be developed is by inbreeding, as Prof. Ewart and others have maintained.

Therefore, as inbreeding may be frequent in nature, especially in gregarious and isolated groups, and as it tends to develop prepotency, we are able to understand better how new variations may have been fixed in the course of evolution. And we can appreciate the position maintained by Reibmayr, that the evolution of a human race implies alternating periods of dominant inbreeding, and dominant cross-breeding. The inbreeding gives fixity to character, the cross-breeding averts degeneracy and stimulates new variations which form the raw material of progress.

Until we have more precise statistical data in regard to blended, exclusive and particulate inheritance, we cannot hope to simplify the matter with any security. But perhaps a unified view will be found in the theoretical conception of a germinal struggle in the arcana of the fertilised ovum, a struggle in which the maternal and paternal contributions may blend and harmonise, or may neutralise one another, or in which one may conquer the other, or in which both may persist without combining. We have extended the wide conception of the struggle for existence in many directions; it may be between organisms akin or not akin, between plants and animals, between organisms and their inanimate environment, between the sexes, between the different parts of the body, between the ova, between the spermatozoa, between the ova and the spermatozoa, and Weismann has suggested that it may also be between the constituents of the germ-plasm.

IV. REGRESSION.

We have already referred to the fact that there is a sensible stability of type from generation to generation. "The large," Mr. Galton says, "do not always beget the large, nor the small the small; but yet the observed proportion between the large and the small, in each degree of size and in every quality, hardly varies from one generation to another." In other words, there is a tendency to keep up a specific average. This may be partly due to the action of natural elimination, weeding out abnormalities, often before they are born. But it is to be primarily accounted for by what Mr. Galton calls the fact of "filial regression."

As Mr. Galton puts it, society moves as a vast fraternity. The sustaining of the specific average is certainly not due to each individual leaving his like behind him, for we all know that this is not the case. It is due to a regression which tends to bring the offspring of extraordinary parents nearer the average of the stock. In other words, children tend to differ less from mediocrity than their parents.

This big average fact is to be accounted in terms of that genetic continuity which makes an inheritance not dual, but multiple. "A man," says Mr. Pearson, "is not only the product of his father, but of all his past ancestry, and unless very careful selection has taken place, the mean of that ancestry is probably not far from that of the general population. In the tenth generation a man has [theoretically] 1024 tenth great-grandparents. He is eventually the product of a population of this size, and their mean can hardly differ from that of the general population."

At this point one should discuss reversion or atavism, but it is exceedingly difficult to get a firm basis of fact. The term reversion includes cases where *through inheritance* there reappears in an individual some character which was not expressed in his parents, but which did occur in an ancestor. The character whose reappearance is called a reversion may be found within the verifiable family, within the breed, within the species, or even in a presumed ancestral species.[1]

The best illustrations of reversion are furnished by hybrids. Thus in one of Prof. Cossar Ewart's experiments a pure white fantail cock pigeon, of old-established breed, which in colour had proved itself prepotent over a blue pouter, was mated with a cross previously made between an owl and an archangel, which was far more of an owl than an archangel. The result was a couple of fantail-owl-archangel crosses, one resembling the Shetland rock-pigeon, and the other the blue rock of India.

But great carefulness is necessary in arguing from the results of hybridisation to those of ordinary mating, and even if some of the phenomena of exclusive inheritance seem to show reversion

[1] Prof. Karl Pearson defines a *reversion* as "the full reappearance in an individual of a character which is recorded to have occurred in a *definite* ancestor of the same race," and *atavism* as "a return of an individual to a character not typical of the race at all, but found in allied races supposed to be related to the evolutionary ancestry of the given race." "In reversion we are considering a variation, normal or abnormal, from the standpoint of *heredity in the individual*; in atavism we are considering an abnormal variation from the standpoint of the *ancestry of the race*." But the two words seem to be used by some authors in the converse way, or as equivalent, and it is surely difficult to define the field of abnormal variation.

to a near ancestor we need a broader basis of fact than we have at present before we can formulate any law. The recorded cases show that many phenomena are labelled reversions on the flimsiest evidence. Thus the occurrence of a Cyclopean human monster with a median eye has been called a reversion to the sea-squirt, and gout has been called a reversion to the reptilian condition of liver and kidneys. Often there is not the slightest attempt to discriminate between true reversion (*i.e.* the re-expression of latent ancestral characters) and the phenomena of arrested development, or of abnormalities which have been induced from without. Often, too, there has been no scruple in naming or inventing the ancestor to whom the reversion is supposed to occur, although evidence of the pedigree is awanting; and the vicious circle is not unknown of arguing to the supposed ancestor from the supposed reversion, and then justifying the term reversion from its resemblance to the supposed ancestor. Little allowance has been made for coincidence, and the postulate of characters remaining latent for millions of years is made as glibly as if it were just as conceivable as a throw-back to a great-grandfather.

There seems no way out of the theory that characters may lie latent for a generation or for generations, or in other words that certain potentialities or initiatives which form part of the heritage may remain unexpressed for lack of the appropriate liberating stimulus, or for other reasons, or may have their normal expression disguised. But it does not follow that the reappearance of an ancestral character not seen in the parents is necessarily due to the reassertion of latent elements in the inheritance. It may be a case of ordinary regression; it may be a case of arrested development; it may be an extreme variation whose resemblance to an ancestral characteristic is a coincidence; it may be an individually acquired modification, reproduced apart from inheritance, by a recurrence of suitable external conditions, and so on. What are called reversions are probably in many cases misinterpretations.

V. GALTON'S LAW.

The most important general conclusion which has yet been reached in regard to inheritance is formulated in Galton's Law. Mr. Galton was led to it by his studies on the inheritance of human qualities, and more particularly by a series of studies on Basset hounds. It is one of those general conclusions which have been reached statistically, and I must refer for the evidence and also for its strictest formulation to the revised edition of Mr. Pearson's "Grammar of Science."[1]

As we have seen, it is useful to speak of a heritage as dual, half derived from the father and half from the mother. But the heritable material handed on from each parent was also dual, being derived from the grandparents. And so on, backwards. We thus reach the idea that a heritage is not merely dual, but in a deeper sense multiple.

To appreciate the possible complexity of our mosaic inheritance we must recall the number of our ancestors. We have two parents, four grandparents, eight great-grandparents, about sixteen great-great-grandparents, and so on. But as we go backwards the theoretical number far exceeds the reality; a reduction in the number of ancestors is brought about by inter-marriage, as this table (from Lorenz) in reference to Kaiser Wilhelm II. clearly shows.

Generations.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
(1) Theoretical Number.	2	4	8	16	32	64	128	256	512	1024	2048	4096
(2) Actual number known.	2	4	8	14	24	44	74	111	162	206	225	275
(3) Inadequately known.								5	15	50	117	258
(4) Probable total.								116	177	256	342	533

According to Galton's Law, "the two parents between them contribute *on the average* one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter, or each of them one-sixteenth; and so on, the sum of the series, $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$&c., being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow: thus $\frac{1}{2}=\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$&c.; $\frac{1}{4}=\frac{1}{8}+\frac{1}{16}+$&c., and so on. The prepotencies or subpotencies of particular ancestors, in any given pedigree, are eliminated by a law that deals only with *average* contributions, and the varying prepotencies of sex in respect to different qualities are also presumably eliminated."

The aim of this lecture has been to present in brief compass a statement of the leading facts of inheritance, which should be clear in the minds of all. Nothing has been said in regard to the transmissibility of acquired characters, for this cannot be ranked at present as an established fact, and some other doubtful points have been left unmentioned. The study of inheritance leaves a fatalistic—almost paralysing—impression on many minds, especially perhaps if it be believed that the acquired results of experience and education—of "nurture," in short, cannot be entailed upon the offspring. To some extent this fatalistic impression is justified, but it is well that it should rest upon a sound basis of fact and not on exaggerations. In a sense we can never get away from our inheritance. As Heine said half bitterly, half laughingly, "A man should be very careful in the selection of his parents." On the other hand, although the human organism changes slowly in its heritable organisation, it is very modifiable individually, and "nature" can be bettered by "nurture." If there is little scientific warrant for our being other than sceptical at present as to the inheritance of acquired characters, this scepticism lends greater importance than ever, on the one hand, to a good "nature," to secure which for offspring is part of the problem of careful mating; and, on the other hand, to a good "nurture," to secure which for our children and children's children is one of the most obvious of duties, the hopefulness of the task resting upon the fact that, unlike the beasts that perish, man has a lasting external heritage, capable of endless modification for the better.

[1] Reference should, however, be made to Mr. Pearson's recent paper *Proc. Roy. Soc.*, lxvi. 1900, pp. 140–164) on the law of reversion.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. A. RENDLE SHORT, of University College, Bristol, has been awarded the gold medal and exhibition in physiology, the gold medal and exhibition in materia medica, and first-class honours in anatomy, upon the results of the recent Intermediate M.B. examination of the University of London. The exhibitions in physiology and materia medica are of the value of 80*l.* and 60*l.*

A DISCUSSION on the teaching of geography will be held at Cambridge on Friday, August 24, under the auspices of the Geographical Association, and in connection with the Summer Meeting. Prof. W. M. Davis, of Harvard University, will occupy the chair, and among the subjects to be brought before the Association are class excursions, map drawing, the use of the globe, geography in the grammar school, and possibilities and limitations of geography in a day school. There are several exhibits of interest to teachers of geography in the education exhibition, arranged in connection with the Summer Meeting.

LORD BUTE has offered the University of St. Andrews a sum of 20,000*l.*, to be held as a fund for endowing a chair of anatomy, upon the following conditions:—(1) That the said sum of 20,000*l.* shall be paid to the University not later than ten years hence. The exact date cannot be specified, as it will depend upon completion of certain works at Cardiff. Interest at 3 per cent. will be payable to the University from the time of the appointment of the first professor until they receive the principal sum; (2) that the first presentation to the chair shall be in favour of Mr. Musgrove, the present holder of the lectureship in anatomy in St. Andrews; (3) that the lectures shall be given exclusively in St. Andrews; (4) that the course shall meet the requirements of the two first *Anni Medici*; and (5) that before the beginning of the University session, 1901–1902, the approval of the Universities Committee of the Privy Council to the establishment of the chair under the foregoing conditions be obtained, and that the approval of Lord Bute or his representatives be obtained to any further conditions embodied in the ordinance instituting the chair.

THE relations between scientific work and industrial progress have been so often described in these columns that there is little new to be said upon the subject. But though readers of NATURE may be familiar with many instances of the close connection between science and industry, it will be a long time before the knowledge filters down to the general public and starts a reaction in commercial and manufacturing circles. Every man of science who takes advantage of an opportunity to impress the value of scientific observation and research upon the minds of citizens,

is thus doing a service to the nation, as well as extending interest in natural knowledge. Dr. P. Bedson, professor of chemistry at the Durham College of Science, has, we are glad to see, recently shown the Economic Society of Newcastle-on-Tyne some of the lessons taught by the growth of science and industry in Germany during the present century. A reasonable and organised system of education, and schools in which students receive a thorough grounding in the principles of science, and afterwards contribute something to the advancement of knowledge, are the chief factors in Germany's industrial progress. Referring to the system of examinations which still dominates so much of our educational work, and finds its highest development in connection with university teaching, Prof. Bedson points out that it partakes of the character of the training of a stud of racers. He adds:—"Possibly the instinct of sport, so characteristic of the English people, it is which commends the system of competitive examination. Too much is made of what should be regarded as a minor duty of the University, viz. the testing and marking of its students, and too little of the higher function, the training of students under first-rate teaching, with the object that those so trained should help forward the advancement of knowledge." It is satisfactory to know that the movement in favour of rational teaching in elementary schools, and regard for research in institutions of university rank, is gradually affecting scientific education in this country.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, July.—This number contains the completion of two interesting papers, by Mr. E. D. Archibald, on Indian famine-causing droughts, and their prevision. The principal facts are summarised as follows: (1) Extensive droughts occur in the dry area of Southern India at intervals of nine to twelve years, and usually, but not regularly, about a year before the sun-spot minimum. When the conditions are sufficiently acute, famine occurs in the following year. (2) A severe drought in the peninsular of Southern India is followed by a severe drought and ensuing famine in Northern India in about five cases out of seven. (3) Summer droughts tend to occur in Northern India in years of maximum sun-spot, connected in some way with the abnormal high pressure over Western Asia which prevails at such epochs. There is thus a double periodicity of droughts and famine in North India, and a single periodicity in South India in the sun-spot cycle, though the relation between the phenomena is too spasmodic and irregular to be utilised as a trustworthy factor for prevision.

Annalen der Physik, No. 6.—Interruption spark in the alternating circuit with metallic electrodes, by L. Kallir. The author shows that the impossibility of producing an alternate-current arc between metallic electrodes is due to the fact that the spark is confined to one semi-period of the current. Or if it extends over several periods, it is intermittent, and only appears at every alternate semi-period.—Thermoelectric force of some metallic oxides and sulphides, by A. Abt. Pyrolusite, pyrrhotite, pyrites, and chalcopyrite were used in conjunction with various metals or with each other. A pyrites-chalcopyrite couple gave an E.M.F. 10·8 times as high as an antimony-bismuth couple under the same conditions.—Anomalous electromagnetic rotatory dispersion, by A. Schmauss. Measurements of the Faraday effect for various wave-lengths in fuchsine solutions and in didymium glass justify the general conclusion that optical anomaly in dispersion is invariably associated with a corresponding electromagnetic anomaly. In strongly absorbing media the anomaly extends for a considerable distance on both sides of the absorption band, and it increases with the concentration and with the narrowness and sharpness of the absorption band.—Point discharges, by E. Warburg. In carefully purified nitrogen, the current intensity obtained from the discharge of a fine point charged to -3310 volts is 200 times as great as from a point charged to $+5180$ volts. A slight admixture of oxygen reduces the proportion to 4 : 1.—Band spectrum of aluminium, by G. A. Hemsalech. The author quotes some experiments which go to show that the band spectrum of aluminium is due, not to the oxide, but to the metal itself.—Behaviour of radium at low temperatures, by O. Behrendsen. Cooling a radium preparation down to the temperature of liquid air reduces its activity by 50 per cent. Restoration to the ordinary temperature produces a considerable but transient increase of activity.—Production of kathode rays by ultra-violet light, by P. Lenard. The discharge of electrified bodies by ultra-violet light is due to their emitting kathode rays when the ultra-violet light impinges upon them. The author exhausted a vacuum tube until it no longer allowed any discharge to pass. He then exposed the kathode to ultra-violet rays from a zinc spark gap. The discharge set in again immediately, but no discharge could be obtained by similarly illuminating the anode. The rays which produce the discharge across the absolute vacuum can be deflected by a magnet, and their velocity is about one-thirtieth of the velocity of light.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 8.—"On Electric Touch and the Molecular Changes produced in Matter by Electric Waves." By Jagadis Chunder Bose, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta. Communicated by Lord Rayleigh, F.R.S.

It is claimed that the experiments described in the paper show:—

(1) That ether waves produce molecular changes in matter.

(2) That the molecular or allotropic changes are attended with changes of electric conductivity, and this explains the action of the so-called coherers.

(3) That there are two classes of substances, positive and negative, which exhibit opposite variations of conductivity under the action of radiation.

(4) That the production of a particular allotropic modification depends on the intensity and duration of incident electric radiation.

(5) That the continuous action of radiation produces oscillatory changes in the molecular structure.

(6) That these periodic changes are evidenced by the corresponding electric reversals.

(7) That the "fatigue" is due to the presence of the "radiation product," or strained B variety.

(8) That by means of mechanical disturbance or heat, the strained product can be transformed into the normal form, and the sensitiveness may thereby be restored.

June 21.—"An Experimental Investigation into the Flow of Marble." By Frank D. Adams, M.Sc., Ph.D., Professor of Geology in McGill University, Montreal, and John T. Nicolson, D.Sc., M.Inst.C.E., Head of the Engineering Department, Municipal Technical School, Manchester. Communicated by Prof. H. L. Callendar, F.R.S.

The following is a summary of the results arrived at:—

(1) By submitting limestone or marble to differential pressures exceeding the elastic limit of the rock and under the conditions described in this paper, permanent deformation can be produced.

(2) This deformation, when carried out at ordinary temperatures, is due in part to a cataclastic structure and in part to twinning and gliding movements in the individual crystals comprising the rock.

(3) Both of these structures are seen in contorted limestones and marbles in nature.

(4) When the deformation is carried out at 300° C., or better at 400° C., the cataclastic structure is not developed, and the whole movement is due to changes in the shape of the component calcite crystals by twinning and gliding.

(5) This latter movement is identical with that produced in metals by squeezing or hammering, a movement which in metals, as a general rule, as in marble, is facilitated by increase of temperature.

(6) There is therefore a flow of marble just as there is a flow of metals, under suitable conditions of pressure.

(7) The movement is also identical with that seen in glacial ice, although in the latter case the movement may not be entirely of this character.

(8) In these experiments the presence of water was not observed to exert any influence.

(9) It is believed, from the results of other experiments now being carried out but not yet completed, that similar movements can, to a certain extent at least, be induced in granite and other harder crystalline rocks.

"On the Effects of Changes of Temperature on the Elasticities and Internal Viscosity of Metal Wires." By Andrew Gray, LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow, and Vincent J. Blyth, M.A., and

James S. Dunlop, M.A., B.Sc., Houldsworth Research Students in the University of Glasgow.

"The Distribution of Molecular Energy." By J. H. Jeans, B.A. Communicated by Prof. J. J. Thomson, F.R.S.

PARIS.

Academy of Sciences, July 23.—M. Maurice Lévy in the chair.—Notice on Charles Friedel, by M. Georges Lemoine.—Visual observations of the corona of May 28, made by Mr. W. H. Wesley at Algiers, with the Coudé equatorial of 0·318 metre aperture, by M. Lœwy.—Phosphoric acid in the presence of saturated solutions of calcium bicarbonate, by M. Th. Schlœsing. Solutions of phosphoric acid were added to saturated solutions of calcium bicarbonate, and carbon dioxide withdrawn by a slow current of air. From the analyses of the precipitated salt, interesting conclusions are drawn as to the use of superphosphates as manure.—Report upon the proposed revision of the arc of the meridian at Quito, by M. Poincaré. The Commission report that it is of opinion that the proposed revision of the arc of meridian at Quito should be carried out. The arc measured should be 6° instead of 4° 5′, the work being done by the staff of the Geographical Service of the Army under the control of the Academy of Sciences.—On the limited problem of three bodies, by M. Lévi-Civita.—On the position and actual appearance of a new star, transformed into a nebula, by M. G. Bigourdan. The nebular constitution ascribed by Prof. Pickering to this new star, discovered by Mrs. Fleming, must have been derived from spectroscopic examination, since at the present time the object appears clearly as a star, without any trace of nebulosity.—Total eclipse of the sun of May 28. Note on the observations made at the Observatory of Algiers, by W. H. Wesley. A description of the study of the lower coronal regions.—Observations of the total eclipse of the sun of May 28, made in Spain, at Hellin, Albacete, and at Las Minas, by M. G. Bigourdan.—Observation of the solar eclipse of May 28, made at Albacete, in Spain, by M. J. Eysséric.—Observation of the total eclipse of the sun of May 28, at Las Minas, in Spain, by M. Salet.—On a system of differential equations equivalent to the problem of n bodies, but admitting of one more integral, by M. W. Ebert.—On the elastic flying machine, by M. L. Lecornu.—On the electrocapillary functions of aqueous solutions, by M. Gouy.—The spectrum of radium, by M. Eug. Demarçay. Mme. Curie has succeeded in obtaining a specimen of radium chloride in which the barium is so far reduced that only a feeble spectrum of three principal rays is obtained. The radium lines, although much stronger than in the specimens previously studied, show no new ray that can be attributed to radium. In its general character the spectrum of radium approximates to those of the metals of the alkaline earths.—Solubility of a mixture of salts having a common ion, by M. Charles Touren.—On a new complex acid and its salts, palladio oxalic acid and palladio-oxalates, by M. H. Loiseleur. Four new substances are described, palladio-oxalic acid and its silver, sodium, and barium salts. The acid is the first complex acid containing palladium that has been isolated.—On some osmyloxalates, by M. Wintrebert.—Action of some finely divided metals, platinum, cobalt and iron, upon acetylene and ethylene, by MM. Paul Sabatier and J. B. Senderens. Platinum black has no action upon pure acetylene at ordinary temperatures, but at 150° ethylene and hydrogen, together with small quantities of benzene and ethane, are produced. With cobalt, the reaction commences at 200°, ethane and hydrogen being the principal products. Iron behaves similarly to cobalt. With ethylene, platinum and copper produce practically no effect; cobalt gives ethane, hydrogen and methane, and similarly with iron.—Synthesis of paramethoxyhydratropic acid, by M. J. Bougault. The author concludes that in identifying phloretic acid with the synthetical paraoxyhydratropic acid, M. Trinius was in error.—Influence of hydrobromic acid upon the velocity of the reaction of bromine upon trimethylene, by M. G. Gustavson.—The organic solutions of ferric chloride, by M. Œchsner de Coninck. The iron salt is removed from solutions in methyl and ethyl alcohols, acetic ether and acetone by repeated filtration through animal charcoal.—On the nature of the reserve carbohydrates of the St. Ignatius bean and nux vomica, by MM. Em. Bourquelot and J. Laurent. The albumen of these seeds appears to contain several mannane and galactanes of different molecular weights.—On the genera Palythoa and Epizoanthus, by M. Louis Roule.—A teratological process, by M. Etienne Rabaud.—The nepheline rocks of the Puy de Saint-Sandoux, by M. A. Lacroix.—The sub-Pyreneal erosions, by M. L. A. Fabre.—On the existence of carboniferous strata in the region of Igli, by M. Ficheur.—On the agglutination of blood corpuscles by chemical agents, and on the conditions of medium which favour or prevent it, by M. E. Hédon.—On the influence of phosphates and of some other mineral substances upon the proteolytic diastase of malt, by MM. A. Fernbach and L. Hubert.—The bacteriolysis of anthrax, by M. G. Malfitano.—On the function of the nucleus in the formation of hæmoglobin and in cellular protection, by M. Henri Stassano.—On the collection of potable water and protection of springs, by M. Léon Janet.

CAPE TOWN.

South African Philosophical Society, June 27.—L. Péringuey, President, in the chair.—Mr. E. H. L Schwarz exhibited copies of some Bushman drawings which he had found near Nieuwoudtsville. Along with the usual reproductions of men and animals, there are certain puzzling figures which have not been recorded from other localities. One of these consists of a rude slipper-like form with seven bars across it; another is a circle with seven peripheral radiating bars, and a third shows three concentric circles, from the outer of which there extend twenty-one bars. Mr. Schwarz thought that the first-mentioned figure might be a tally.—Dr. Corstorphine gave a short note on an old beach deposit on the site of the South African Brewery at Woodstock, which had been brought to his notice by Mr. A. W. Ackermann, architect, Cape Town. Some of the sections show a layer of shells and water-worn boulders some three feet thick resting on the slate and covered by about three feet of sand and soil, but within thirty yards the deposit entirely thins out. The shells all belong to species found on the present beach.—A copy of a report on a submarine disturbance, from the magistrate at Walfish Bay, forwarded by Major Stanford, was read by the secretary. The magistrate stated that on May 31 or June 1 last, a new island appeared about 100 yards N.E. of Pelican Point. The island was about 150 feet long by 30 feet wide, and stood 12 feet above high water. It was composed of a tenacious clay; soundings gave 7–10 fathoms around it; steam was observed rising from the clay, and an intense smell of sulphuretted hydrogen was perceptible, even at a distance of five miles.—Mr. Sclater gave an account of some inscribed stones found in Cape Town.

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